

First Aero Weekly in the World.

Founder and Editor: STANLEY SPOONER

A Journal devoted to the Interests, Practice, and Progress of Aerial Locomotion and Transport

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DIARY OF FORTHCOMING EVENTS

Club Secretaries and others desirous of announcing the dates of important fixtures are invited to send particulars for inclusion in the following list:—

- Jan. 24 "Fabric and Dopes," by Dr. Ramsbottom, before R.Ae.S.
- Feb. 7 "Airmanship at Sea," by Sqd.-Ldr. Maycock, O.B.E., R.A.F., before R.Ae.S.
- Feb. 21 "Aerial Photography and Survey," by Mr. H. Hamshaw Thomas, before R.Ae.S.
- Mar. 1 French Aero Engine Competition.
- Mar. 6 "Sound Detection," by Major Tucker, before R.Ae.S.
- Mar. 20 "The Report of the Aeronautical Research Committee's Panel on Scale Effect," by Capt. W. S. Farren.
- April 1 Entries close for Schneider Cup and Gordon Bennett Balloon Races
- April 3 "The British Aviation Mission to the Imperial Japanese Navy," by Colonel the Master of Sempill, before R.Ae.S.
- June 15 Gordon Bennett Balloon Race, Belgium
- June 21 F.A.I. Conference Opens, Paris

EDITORIAL COMMENT.



IN Sir Samuel Hoare, the Air Minister in Mr. Baldwin's Government, was found an ideal man for the post. Of clear and far-seeing outlook, he had the added valuable asset of being a highly-trained business man with no hide-bound traditions to hamper his decisions. At the time of his appointment we applauded it for these reasons, qualified with the proviso that, in practice, we could only hope to see his great talents properly applied, and thus leave it and "wait and see." As every one knows, Sir Samuel made good in every sense of the word, and for that reason it is a matter of great regret that an executive position of this character cannot be outside the shifting sands of politics.

At the same time, there are undoubtedly always as good fish in the sea as ever came out of it, and as the new Air Minister, Brig.-Gen. Thomson, is, like Sir Samuel Hoare, somewhat of an untried quantity in the administration of the affairs of the Air, we can only again hope that results will more than justify the appointment which Mr. Ramsay MacDonald has been pleased to make. General Thomson's past record is of such a nature that at least there should be great promise of his taking a very strong line in our Air Control in the direction of the Services, and we hope equally strong in regard to the development of the Civil Side, whether as a unit in itself or as allied to the R.A.F. side of the problem.

In regard to Brig.-Gen. Thomson's career, the son of Major-Gen. David Thomson, he was born in 1875, and was commissioned in the R.E. He served in the Mashonaland and South African campaigns, passed through the Staff College and was on War Office Staff from 1911-14. In August 1914, he went to France on the Staff of the First Army Corps under Sir Douglas Haig, and in 1915 became Military Attaché to Rumania, and later was head of the Military Commission there. He visited Russia both before and after the Kerensky revolution. He served in Palestine and was at Versailles as British Military Representative on the Supreme War Council.

Reorganising Research

It has long been obvious that the present organisation of the control of aeronautical research was a long way from being ideal, and on several occasions complaints have been voiced in public that those in high places appeared to have failed to realise the importance of fundamental research. Also it has been freely stated that gradually the term research had been interpreted in certain official circles, and had been made to cover, as meaning a form of research that would have been better described as experiment. Compromises were made and a certain improvement effected in the co-operation of those whose work and aims were pure research and those engaged upon what has been termed *ad hoc* experiments. Nevertheless, the arrangement was but a compromise, and it was felt that something better was needed.

It has now been decided, as announced below, to abolish the Directorate of Research and to supplant it with two new Directorates: The Directorate of Scientific Research and the Directorate of Technical Development. It might have been thought that we already had more than enough of "Controllerates," Directorates and other "ates," and that to establish new departments at the present time was a luxury that might well have been avoided. We think, however, that here is a case where a division of responsibilities was really required, and that the move, which at first sight might appear merely to indicate a duplication of staffs and departments, is a wise one.

Hitherto the position has been that the Director of Research was responsible, under the Air Council Member for Supply and Research, on the one hand for scientific research and on the other for the applica-

tion of the results of such research to the technical development of aircraft, aero engines and accessories. Now the Air Member for Supply and Research is always a senior officer in the R.A.F., and the post of Director of Research also is always filled by officers of the Service. Consequently it was to be expected that there might be a tendency to favour experimentation rather than pure research, and to expend such money as was available on subjects promising a more immediate return than on those more uncertain, and the value of which could not readily be assessed. We are not presuming to blame the officers who are holding and have held these posts. They have, within the financial and service limits that surrounded them, done their best and really not done at all badly. The fault has been with the system and not with individuals.

Under the new scheme the Director of Technical Development will be an officer of the R.A.F., while the post of Director of Scientific Research will be filled by a civilian of high standing and possessing special qualifications for the particular kind of work with which his department will deal.

The Director of Scientific Research and the Director of Technical Development will, of course, both serve under the Air Member for Supply and Research, and thus both sides should, theoretically, be entitled to an equal hearing. We have sufficient faith in the impartiality of the Air Member for Supply and Research to believe that he will see to it that in the future scientific research will have its case clearly and fully stated before the Air Council, and that as a result of the new arrangement the neglect of past years will be to a great extent remedied.

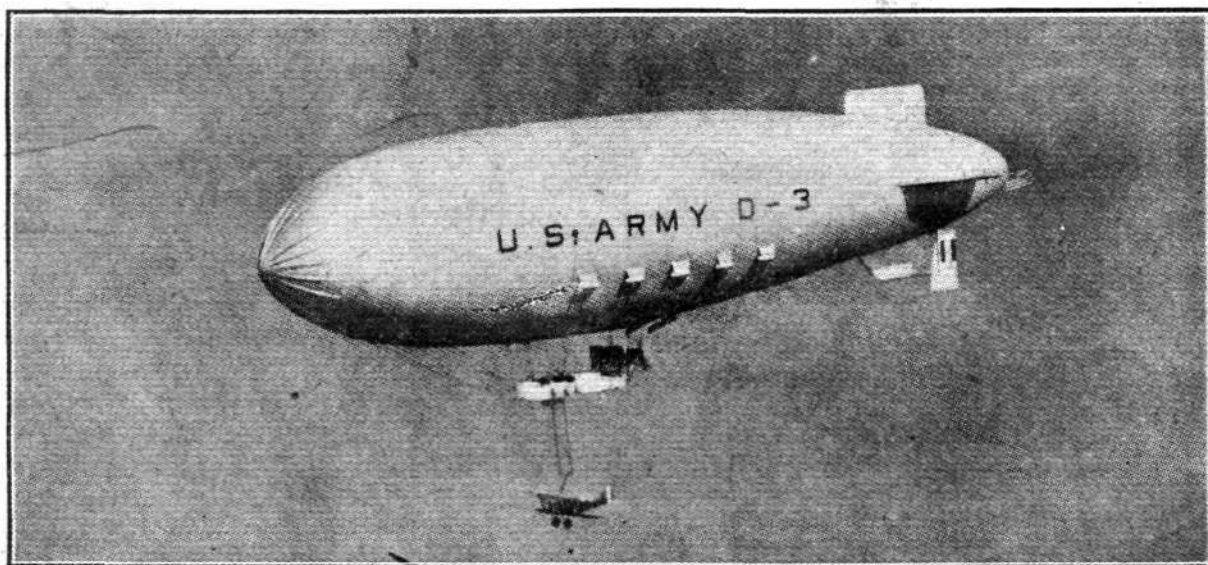


Reorganisation of Aeronautical Research

THE Air Ministry announces a reorganisation of the arrangements for the control of Aeronautical Research. Hitherto the Director of Research has been responsible, under the Air Member for Supply and Research, on the one hand for the direction of scientific research on all aeronautical matters, and on the other hand for the application of the results of such research, as well as of practical flying experience, to the technical development of aircraft, aero engines and all accessories, in order to meet the requirements of the Royal Air Force and of Civil Aviation. The rapid development of aeronautical science and the increased requirements of the Royal Air Force have now made necessary a re-allocation of the responsibilities of the Director of Research; and as from April next the control of the one side of the work

will be transferred to a Director of Scientific Research, while the other side will be assigned to a Director of Technical Development. The appointment of Director of Research will then lapse. The Director of Scientific Research and the Director of Technical Development will both serve under the Air Member for Supply and Research, and the former, we understand, will be a civilian having high scientific qualifications and, if possible, a knowledge of aeronautical research, whilst the D.T.D. will be an experienced senior officer of the R.A.F. Appointments to the new posts will be announced in due course. The effect of this reorganisation will be to give scientific research the free scope for development which the recent growth of service and civil flying renders necessary.

We refer elsewhere to this new and, we think, important rearrangement.



THE FIRST MID-AIR CONTACT BETWEEN AIRSHIP AND AEROPLANE: On September 18 last, Lieut. R. K. Stoner, flying a Sperry "Messenger," maintained contact with the U.S. Army Blimp Airship, "D.3," for about one minute over Langley Field.

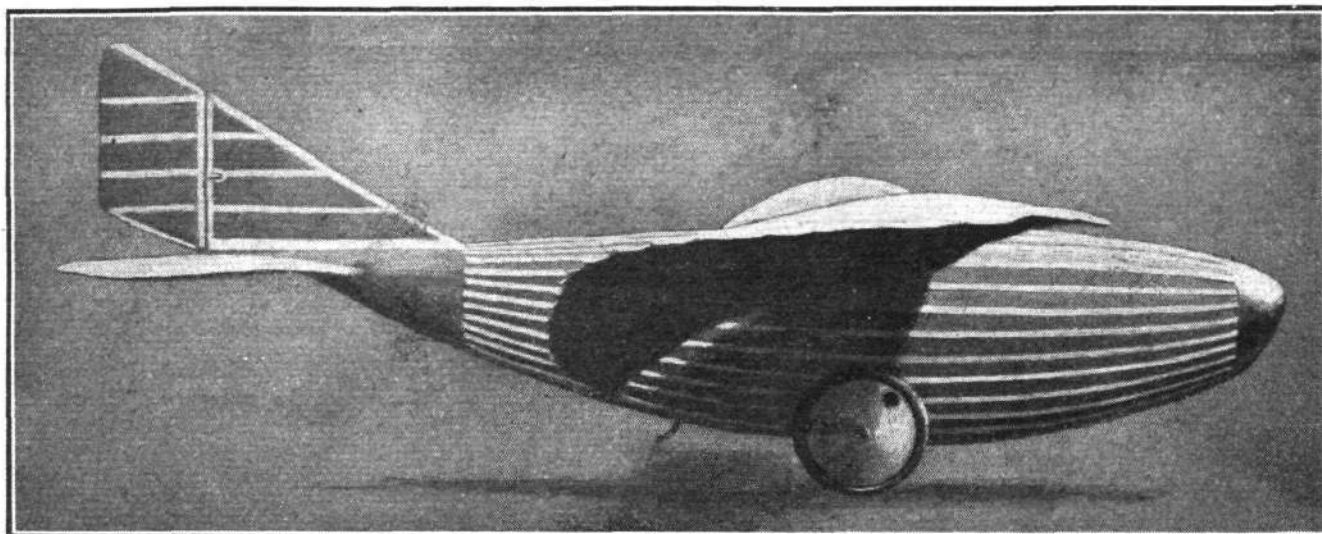
THE MAGNAN MONOPLANE GLIDER

A French Machine Designed for Gust-Soaring

WHILE soaring in an up-current of air, over the slope of a hill or range of hills, presents no particular difficulty, provided the rising current is strong enough and the machine has a sufficiently good gliding angle and ample controllability, gliding in a horizontal wind, by making use of such turbulence as exists in the wind, is at present outside the practical possibility, although theory indicates that a certain amount of energy should be available for soaring flight. This form of gliding, which has been termed "gust-soaring" has been

as well as for the illustrations, we are indebted to our French contemporary *L'Air* of January 1, 1924, in which appears an article by M. Andre Lesage dealing with the Magnan glider.

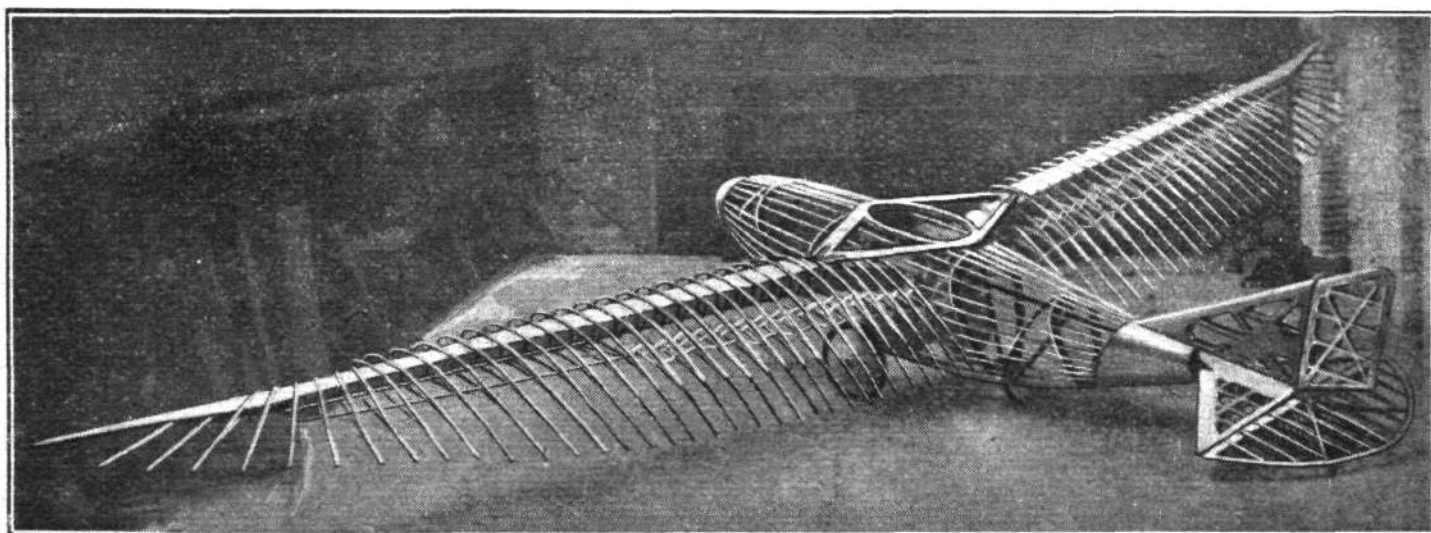
Basing his design to some considerable extent upon the characteristics of web-footed birds, Dr. Magnan has produced a cantilever monoplane, the wing of which is of uniform chord over approximately one-half of its span, but tapering to a point at the tips. The leading edge, it will be seen, is straight and the taper is provided solely by the trailing edge,



THE MAGNAN MONOPLANE GLIDER: Side view.

examined theoretically by Knoller and Betz, and experimentally in the wind tunnel at Göttingen. In both cases the conclusions reached were that a not inconsiderable amount of energy was present which, with a suitable machine, should be available for flight. A few experiments with man-carrying machines have been made, but with rather inconclusive results. It should be remembered that it is very often difficult to distinguish between true "gust-soaring" and gliding in a wind having, perhaps quite unsuspectedly, an upward vertical component, and that in many instances during a glide a machine may be helped partly by one and partly by the other form of energy.

Near the root the wing is swept down suddenly and sharply to form a pronounced dihedral angle. This angle, however, extends over but a few feet of the span, and the rest of the wing is at a smaller, although still considerable, dihedral. The wing tapers in thickness as well as in chord, and the angle of incidence is progressively altered, being in the neighbourhood of 20 degrees at the root, where the wing joins the body. In addition to the change in section and angle, the wing is unusual in that the ribs are so constructed that they are capable of being flexed to a very considerable extent under varying loads. Thus one can scarcely speak of any particular wing section in the Magnan monoplane since the

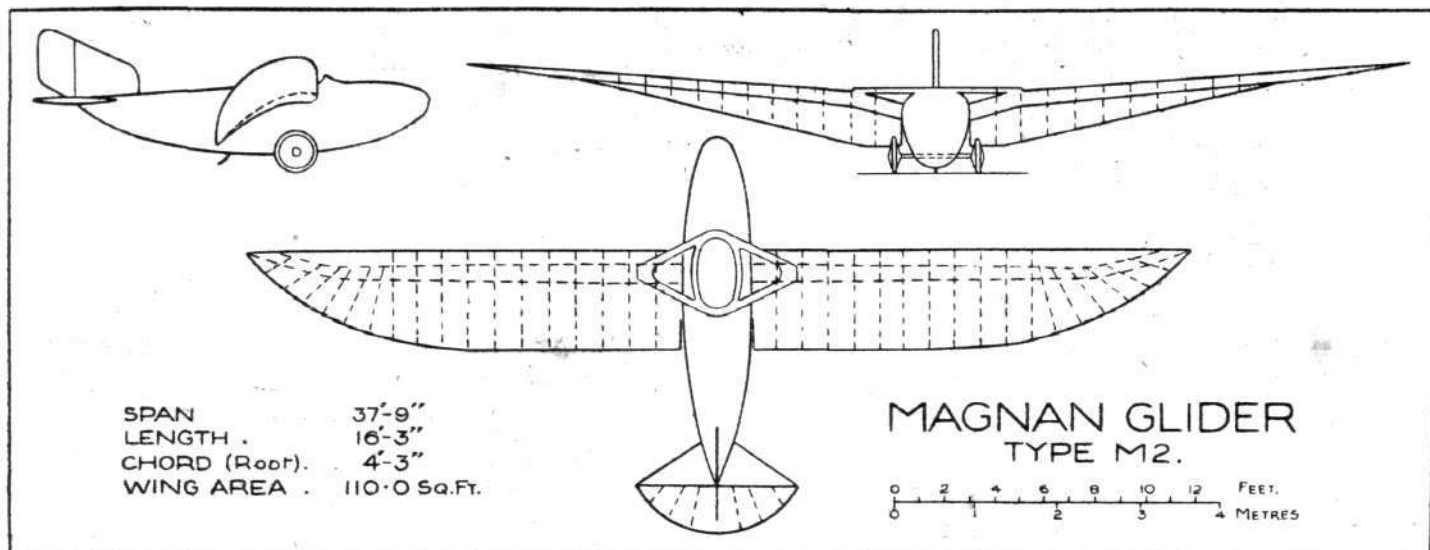


THE MAGNAN MONOPLANE GLIDER: Three-quarter rear view of machine in skeleton.

Apart from the studies made in Germany, several French experimenters have attacked the problem of "gust-soaring," among them being Dr. Magnan, who has made a close study of bird flight, and who has now reached a stage when he feels that the theories involved are sufficiently well, although not completely, understood to justify the building of a machine for the purpose of carrying out actual flying experiments. This machine, which forms the subject of the following notes, is of unorthodox design, both aerodynamically and structurally, and for the information on which the description is based,

number of variables is unusually great. It will be noticed from the drawings that no ailerons are fitted. Lateral control is by wing warping.

The fuselage is short in proportion to the span, and an exceptionally large portion of it projects ahead of the wing. This results in the tail being very close to the wing, only about one chord-length separating the trailing edge from the forward end of the fixed tail plane. It appears rather doubtful whether directional control will be sufficient under these circumstances, although a fairly large rudder is fitted.



THE MAGNAN MONOPLANE GLIDER: General arrangement drawings.

The "fin area" of the forward portion of the fuselage is very considerable, although of rounded section, and altogether the machine does not look reassuring from the point of view of directional stability. It would seem that the designer has attempted to copy the outward shape of a bird without taking into consideration that the range and number of movements of which a bird's wing is capable enable it to carry out with perfect safety manoeuvres which a machine outwardly resembling the bird but lacking its adaptability could not hope to imitate.

Constructional Features

Constructionally no less than aerodynamically the Magnan glider is somewhat unusual. The monoplane wing has but a single spar, of box section and built of wood. The construction of this spar must have presented considerable difficulties, as there are two fairly sharp bends in each spar, one a few feet out from the body, where the horizontal *cabane* meets the spar, and another (this in a horizontal plane) a few feet from the tip, where the spar tip is swept forward to meet the straight leading edge. The ribs have top and bottom flanges of ash, the lower flange, which runs from leading to trailing edge, being screwed and glued to the lower face of the spar. The top flange stops short of the trailing edge, about one-third of the chord from it, and is so attached to the lower flange and to the spar that it can slide a short distance in a fore-and-aft direction, thus allowing the trailing edge to flex. The details of the arrangement are not available, but we understand that they constitute a patent. Near the wing tips the ribs slope outwards, and also they are so mounted on the spar as to give a pronounced "wash-out" to the wing. Lateral control is by warping, but instead of the warp causing a change of angle without sensible change in camber, in the Magnan monoplane both angle of incidence and camber are altered. It would appear that the force on the control column necessary to produce the required amount of warp must be very considerable. The fabric covering is applied in a special way, which is claimed to prevent wrinkling when the wing is being warped.

The fuselage is of egg-shape section, and is built up of formers alternating sloping back and forward, thus forming a series of Vees as seen in side view. To these formers are attached four main longerons and a great number of stringers, and wire bracing is employed for stiffening the structure against torsion. (The Vee formation of the formers plus the four longerons already provide a structure stable under plain bending loads.) The fuselage is fabric covered except at the extreme nose and stern.

The tail is of more or less orthodox design, but is supported

on a duralumin cone bolted to the rear bulkhead of the fuselage proper.

A simple undercarriage consisting of two wheels carried on a duralumin axle is fitted, the axle being sprung by rubber cords anchored inside the lower portion of the fuselage.

The pilot's seat is mounted on longitudinal rails, somewhat like the sliding seat in a boat, and for fore-and-aft control he can alter the position of the centre of gravity by sliding the seat along. The ordinary controls are of the usual type.

The manner in which it is hoped to carry out gust soaring with the Magnan glider is as follows. The machine will be launched from a cliff on the coast, and will glide into the wind until fairly low over the sea. It is assumed that gusts will be present, and that these occur at such intervals as to enable the pilot to manoeuvre the machine in the manner required to extract energy from the fluctuations in the wind. During a gust the pilot will pull back the stick, and if necessary shift his seat back so as to bring the tail down quickly. As the gust dies down he will push the stick forward and slide his seat forward at the same time so as to avoid stalling the machine. During a lull it will be the pilot's endeavour to glide forward with the minimum loss of height, *i.e.*, at the best gliding angle for the particular conditions. As soon as he feels another gust rising he will again elevate, and so the cycle is continued with alternate elevations and depressions. Dr. Magnan considers that another method would be to glide down-wind during the lulls and up-wind during the gusts, but that it is doubtful if the machine could be manoeuvred quickly enough to make this form of gust-soaring feasible.

Some preliminary tests over land have been made with the machine, piloted by Canivet, and these are stated to have indicated that the machine should, under suitable conditions, be capable of taking advantage of a gusty wind.

The main characteristics of the Magnan Monoplane, known as the "Type Marin M.2," are as follows: Length o.a., 4.95 m. (16 ft. 3 ins.); span, 11.5 m. (37 ft. 9 ins.); chord (root), 1.3 m. (4 ft. 3 ins.); wing area, 10.25 sq. m. (110 sq. ft.); weight of wing, 60 kgs. (132 lbs.); weight per sq. ft. of wing, 1.2 lbs.; weight of machine (empty) 130 kgs. (286 lbs.); weight in flying trim, 200 kgs. (440 lbs.); wing loading, 19 kgs./sq. m. (4 lb./sq. ft.). As alighting on the sea will be one of the normal functions of the machine, the fuselage and wings have been made watertight, the opening for the wheel axle being bulkheaded off from the rest of the fuselage. The wing loading, it will be seen, is fairly heavy, and the structural weight appears to be greater than usual in gliders. Probably this is due, mainly, to the wing construction. Actual tests over the sea will be looked forward to with interest.

BRITISH STANDARD METHOD FOR THE DETERMINATION OF VISCOSITY IN ABSOLUTE UNITS (B.E.S.A. Publication No. 188—1923)

The object of this specification is to provide an accurate yet simple and commercially applicable method for the determination of viscosity of a liquid in C.G.S. (centimetre-gramme-second) units. The specification includes standard dimensions for U-tube, co-axial bulb and falling sphere viscometers,

and the standard liquids recommended for their calibration. The use and calibration of the instruments are described in detail, also the method for determining the viscosity of opaque liquids by means of the Lidstone Viscometer, and by the adaptation of the tube and falling sphere viscometers.

Copies of this publication (No. 188—1923) are obtainable from the B.E.S.A., Publications Dept., 28, Victoria Street, S.W. 1.



THE ROYAL AERO CLUB OF THE U.K.

OFFICIAL NOTICES TO MEMBERS.

COMMITTEE MEETING

A meeting of the Committee was held on January 16, 1924, when there were present: Brig.-Gen. Sir Capel Holden, K.C.B., F.R.S. (in the chair), Group-Capt. F. W. Bowhill, C.M.G., D.S.O., R.A.F., Mr. Ernest C. Bucknall, Lieut.-Col. M. O. Darby, Col. F. Lindsay Lloyd, C.M.G., C.B.E., Lieut.-Col. M. O'Gorman, C.B., and the Secretary.

Election of Members.—The following new members were elected:—

Pilot Officer Gerald Fitz-Gerald Atkinson.
Flying Officer George Henry Bittles.
Capt. Frank Entwistle.
Lieut. Edward Spencer Knight Evans-Greaves.
Flying Officer Leslie Gordon Lucas.
Harold James Payn.
Lieut. Rupert Lionel Preston.
Francis Edward Noel St. Barbe.
Flying Officer Stuart Douglas Scott.
Squadron-Leader Frank Nangle Bury Smartt.
Charles Clement Walker.
Flying Officer Albert Edward Woodbridge.
Pilot Officer Frederick Charles Lea Young.

The following Temporary Honorary Members were re-elected for the year 1924:—

U.S.A.—Capt. C. L. Hussey, U.S.N.; Commander J. H. Towers, U.S.N.; Commander J. C. Hunsaker, U.S.N.; Major H. C. Davidson.
France.—Commander L. Sable.
Switzerland.—H. F. Martin.
Italy.—Capt. S. Scaroni.
Belgium.—Capt. W. Coppens.

Racing Committee.—The report of the Racing Committee, held on December 17, 1923, was received and adopted (see separate report).

F.A.I. Conference.—Lieut.-Col. M. O'Gorman reported on the Conference of the F.A.I. held in Paris, January 2-5, 1924 (see separate report). A unanimous vote of thanks was passed to Lieut.-Col. M. O'Gorman for attending on behalf of the Royal Aero Club.

Lancashire Aero Club.—The application for affiliation of the Lancashire Aero Club was received and agreed to.

Society of Model Aeronautical Engineers.—It was decided to renew the official recognition of the Society of Model Aeronautical Engineers as the body to control competitions for Model Aeroplanes for the year 1924.

Selfridge Prize.—Lieut.-Col. M. O. Darby, Vice-Chairman of the Racing Committee, reported that Mr. H. Gordon Selfridge had agreed to extend the date of the competition for a further period not exceeding twelve months, under the same regulations as last year.

Annual General Meeting.—It was decided to hold the Annual General Meeting of the Club on Monday, March 31, 1924.

Light Aeroplane Competition, 1924.—Letter was read from the Air Ministry, dated January 10, announcing that the prize to be offered by the Air Council for the above competition would be £3,000. This was referred to the Racing Committee.

Correspondence.—Letters acknowledging messages of sympathy, sent by the Club in connection with the loss of the "Dixmude," and the death of Mr. L. Sperry, were read.

FEDERATION AERONAUTIQUE INTERNATIONALE

The Conference was held in Paris on January 2-5, 1924. The following countries were represented: Belgium, France, Great Britain, Holland, Italy, Japan, Roumania, Switzerland and the United States. Lieut.-Col. M. O'Gorman and Lieut.-Commander H. E. Perrin of the Royal Aero Club represented Great Britain.

Schneider Cup.—It was decided to run the race under the same regulations as last year. The closing date of entries was fixed for April 1, 1924.

Gordon Bennett Balloon Race.—The closing date for entries was fixed for April 1, 1924.

Tryptique.—The detailed arrangements between the Customs Authorities of the European Countries were considered and approved. The Tryptique only applies to private touring aeroplanes, and will be instituted very shortly.

Records.

Replenishments.—It was decided to institute separate records where replenishments are taken in during flight, under the following categories: Duration, Distance, Height, Speed over a given distance.

Height.—It was agreed that it was not necessary to return to the point of departure in attempts on Height Records.

Speed.—For Speed Records an excess of 8 kilometres per hour was necessary to beat the previous record. It was also decided that for greatest speed records over a 3-kilometre course, the aeroplane must not exceed a height of 400 metres during its approach to the course.

Light Aeroplanes.—The classification of records for light aeroplanes was deferred until after the various competitions this year.

1924 Conference.—The Conference for 1924 was fixed to be held in Paris, commencing June 21, 1924.

Other matters dealt with included The Airman's International Atlas, Chronometers, Regulations for Timekeepers, Barographs for Height Records and a competition for Timing Apparatus for Speed Records.

RACING COMMITTEE

A meeting of the Racing Committee was held on December 17, 1923, when there were present: Major-Gen. Sir W. S. Brancker, K.C.B. (in the Chair), Group-Capt. F. W. Bowhill, C.M.G., D.S.O., R.A.F., Lieut.-Col. M. O. Darby, Lieut.-Col. John D. Dunville, C.B.E., Lord Edward Grosvenor, Mr. W. O. Manning, Lieut.-Col. A. Ogilvie, C.B.E. In attendance: Major J. S. Buchanan, representing the Director of Research, Air Ministry; Capt. Acland; Mr. F. Handley Page; Mr. T. O. M. Sopwith, representing the Society of British Aircraft Constructors, and H. E. Perrin, Secretary.

Light Aeroplane Competition, 1924.—Letter was read from the Air Ministry setting out the conditions proposed for the prize to be offered by the Air Council.

These conditions were agreed, and a sub-committee representing the Club and the Society of British Aircraft Constructors was appointed to recommend a basis for awarding marks for specified performances.

Schneider Cup, 1924.—It was decided to recommend to the F.A.I. that the General Regulations for 1924 should be the same as last year, and to ask for the date, place and nature of course to be made known six months before the race, and, if possible, prior to the closing date of entries, viz., April 1, 1924.

Light Aeroplanes.—It was decided to recommend that cylinder capacity should be the basis adopted for defining light aeroplanes, but that the fixing of the limit should be deferred for the present.

Issue and Renewal of "A" Licences.—The following amendments proposed by the Air Ministry were considered and approved.

Applicants will be required to produce the following evidence showing that they have carried out a minimum of three hours solo flying during the preceding twelve months: (a) Pilot's Log Book, or (b) A Certificate signed by a responsible authority approved by the Air Ministry.

Failing the production of such evidence of recent flying experience, applicants for the renewal of a Private Pilots Licence will be required to carry out the following practical flying tests to be observed by an official observer appointed by the Royal Aero Club: (1) To execute satisfactorily 3 figures of eight; (2) To carry out three landings finally stopping the aircraft within a distance of 50 yards from a point fixed by the candidate before starting.

Private pilots licence will, in future, be issued for a period of 12 months.

GORDON BENNETT BALLOON RACE, 1924

The Gordon Bennett Balloon Race will be held in Belgium on June 15, 1924. British entries, together with the entry fee, £10, must be received by the Royal Aero Club not later than Monday, March 24, 1924.

THE SCHNEIDER INTERNATIONAL SEAPLANE RACE, 1924

The Schneider International Seaplane Race will be held this year in America. The date of the contest will be announced on or before March 1, 1924. British entries, together with the entry fee, £10, and the deposit of £100, must be received by the Royal Aero Club not later than Monday, March 24, 1924.

(The General Conditions are the same as for last year, and were published in full in FLIGHT on January 25, 1923).

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H. E. PERRIN, Secretary.

LIGHT 'PLANE AND GLIDER NOTES

Those wishing to get in touch with others interested in matters relating to gliding and the construction of gliders are invited to write to the Editor of *FLIGHT*, who will be pleased to publish such communications on this page, in order to bring together those who would like to co-operate, either in forming gliding clubs or in private collaboration.

UNDER the Official Notices of the Royal Aero Club this week will be found a reference to the Selfridge 1,000 guinea prize for gliders, stating that Mr. Selfridge has agreed to extend the date for a period not exceeding twelve months from January 1, 1924. Judging from the number of people who have expressed to us their desire for the extension of this prize up to the end of 1924, we believe that this act of generosity on the part of Mr. Gordon Selfridge will be greatly appreciated, and that during the present year more than one attempt to win the prize will be made. Should the 50 miles stipulated not be flown a consolation prize of 500 guineas will be awarded for a flight of not less than 25 miles, to which will be added £20 for every mile in excess of the 25 miles.

THERE seems to be just a possibility that the Royal Aero Club may decide to hold a gliding competition during the present year, and in that event the Selfridge Prize would be open for such a competition, if not won in the meantime. It is to be hoped that it may be found possible to hold another glider meeting this summer, as it seems a great pity to abandon all gliding experiments before we have learned from them all that there is to be learned. As we have repeatedly pointed out, there is little to be gained by further soaring in rising currents. From a scientific point of view the problem has been solved, and from a sporting standpoint any further attempt at increase in duration would be merely monotonous, and depends primarily on the physical endurance of the pilot. Soaring over level country, however, or "gust-soaring" as it has been termed, presents other problems, and further experiments in this direction are needed. In this connection we would refer to the Magnan monoplane described and illustrated in this issue of *FLIGHT*. Although we do not necessarily think the machine an ideal one for this form of flying, it does at any rate represent a serious attempt on the part of a French experimenter who has made a very intimate study of bird flight. Perhaps in this country Dr. Hankin will be willing to co-operate with others who could look after the engineering side for him, and that in this way fresh light might be thrown on a subject which at present appears somewhat obscure. At any rate, we think, the Royal Aero Club should co-opt Dr. Hankin's valuable assistance, if and when it comes to choosing a site for a 1924 glider competition.

In the Royal Aero Club Notes this week confirmation is found of the announcement made in these notes last week that the amount of the Air Ministry Prizes to be awarded for light 'planes is £3,000. This is highly gratifying, and the amount is sufficiently generous to attract a large number of entries. We shall be very surprised if the total number of machines does not reach 50, as it costs very little more to build two machines than one, while constructors who are in doubt as to what engine to fit will, by building more than one machine, be able to multiply their chances of success. It is now high time that the final rules were announced, as there are only about four or five months left in which to design and build the competing machines. We are aware that in aviation it is not customary for constructors to begin work until a fortnight or so before a competition, and then to work night and day so as to get the machine finished. It has often been stated that no matter how long notice was given, machines would never be ready until the day before a competition. While this may be so, it is advisable to publish the rules as soon as possible, and anyway the club will then have the satisfaction of knowing that competitors cannot excuse themselves by laying the blame on the short notice given.

THE light 'plane as a recognised class of aircraft has undoubtedly come to stay, and it has become necessary to define

Materials in Aircraft Construction

WE have been asked to correct any erroneous impression that may have been created by publishing, last week Dr. Aitchison's name side by side with that of Mr. North under the heading of Mr. North's paper on Materials in Aircraft Construction. Our introductory note should have made the matter clear, but in case it failed to do

what constitutes a light 'plane. At present the Racing Committee of the Royal Aero Club is considering the matter, and it is agreed that engine capacity should be used as a basis for defining the class. The actual limit on engine capacity still has to be settled, however, and a decision has been deferred until after this year's competitions. The same applies, as a matter of course, to light 'plane "records," which can scarcely be recognised until the light 'plane class has been defined. The competitions to be held this summer should, however, give reasonably definite information as to what engine capacity is required, when the problem of setting the limit on the class will be considerably facilitated.

IN the future the number of applicants for Air Ministry "A" licences should be much greater than in the past. With the advent of the light 'plane it may be hoped that many more will obtain a pilot's licence for flying private aeroplanes, and consequently the announcement in the Royal Aero Club Notes this week relating to "A" licences is of considerable interest. For one thing, these licences will hold good for twelve months only, and must then be renewed. Proof will be required of three hours' solo flying during the preceding twelve months, and as such proof will be accepted a pilot's log book or a certificate signed by a responsible authority, approved by the Air Ministry. Otherwise applicants for an "A" licence renewal will be required to pass the following practical flying tests: Three figures-of-eight and three landings, finally stopping the machine 50 yards from a point previously indicated by the candidate. These tests will be observed by officials appointed by the Royal Aero Club.

HERR ARTHUR MARTENS, the well-known German glider pilot, has lately been making experiments in the Rhön with his glider "Strolch," fitted with a small auxiliary engine. The "Strolch" is an ultra-efficient monoplane glider, and may be said to represent a refinement of the famous "Vampyr." The engine used in the experiments was a two-cylinder opposed two-stroke of 298 c.c. capacity, known as the Ilomotor. It is manufactured by the Norddeutschen Maschinenfabrik in Pinneberg, Holstein, and develops something like 5 b.h.p. The engine is so mounted in the machine that it can be easily removed if it is desired to use this machine as a glider.

DURING the first flight Herr Martens remained aloft for three minutes and alighted at his point of departure. The machine was catapulted off, as the Wasserkuppe was covered in six inches of snow. The "Strolch" flew quite well with this engine, but doubtless a little more power, such as that provided by the Blackburn 700 c.c. engine, would have been an advantage. At present the machine is to be regarded as a glider fitted with an auxiliary engine rather than as a light 'plane.

It appears that there is considerable difficulty in obtaining in Germany engines really suitable for light 'planes, and this in spite of the fact that the Germans were, perhaps, the first to realise the need for such an engine. The German journal *Flugsport* first took the matter up, and its editor, Herr Oscar Ursinus, who did so much to bring about the resumption of the Rhön experiments, kept hammering away at the necessity for developing a small, light and reliable engine. Nevertheless, the usual German motor-cycle engine does not appear to be suitable, and there would appear to be an opportunity for British engine manufacturers. The rate of exchange is rather a stumbling block, of course, but the difficulties might not be insurmountable.

IN France the publication of the rules governing the *Tour de France* is eagerly awaited. In this country also we look forward to seeing the regulations, as it is quite conceivable that several British machines may be entered for that event, which is to be held before the British competitions, and would thus provide a useful "dress-rehearsal" for machines entered for the latter.

so we point out that the two papers, although dealing with the same subject, were entirely distinct, and that the only degree to which collaboration occurred was in respect of the limits of the subjects to be dealt with in each paper. Thus the paper published last week was entirely due to Mr. North, and that published in the present issue is the work of Dr. Aitchison.

NOTICES TO AIRMEN

Aerodromes for Civil Use : Consolidated List

As usual a Consolidated List has been issued by the Air Ministry in regard to :—

1. Aerodromes, seaplane stations and landing grounds, open to civil aviation in Great Britain and Northern Ireland, and Service and Civil stations, available to civil aircraft in case of emergency only, corrected to January 1, 1924.

2. The lists are classified as usual, each aerodrome or landing ground being given in alphabetical order.

The Notice is No. 1 of 1924, and is obtainable from the Air Ministry.

(No. 1 of 1924.)

NOTICE TO GROUND ENGINEERS

Air Navigation (Consolidation) Order, 1923

It is notified :—

1. The Air Navigation (Consolidation) Order, 1923, came into operation as from January 1, 1924, revoking on that date the Air Navigation Orders, 1922 and 1923. Attention is drawn to certain effects of the new Order, as follows :—

2. *Log Books, etc.*—The journey log book to be kept in respect of every British aircraft registered in Great Britain and Northern Ireland is to be one issued by the Secretary of State. These books will be issued on demand by the Air Ministry at a price of 4s. each. Each book will be issued in respect of an individual aircraft, and the page containing the description of the aircraft will be completed by the Air Ministry. The certificate of airworthiness of the aircraft is to be kept in the pocket of the journey log book, and all aircraft so registered are required to carry this log book when flying. The aircraft and engine log books are no longer required to be carried in the aircraft.

3. *Smoking in aircraft.*—Smoking is prohibited in any aircraft registered in Great Britain and Northern Ireland, wherever such aircraft may be, or in any other aircraft when in or over Great Britain and Northern Ireland.

(NOTE.—The substance of this Notice was issued as Notice to Airmen No. 105 of 1923, and is now republished for the benefit of Ground Engineers.)

(No. 1 of 1924.)



Married

EDGAR J. KINGSTON McCLOUGHRY, D.S.O., D.F.C., of Lee-on-Solent, was married on January 16, at King's Weigh House Church, London, to FREDA ELIZABETH LEWIS, daughter of Sir Alfred and Lady Lewis, Coneybury, Lower Kingswood, Surrey.

Death

Flying Officer ROBERT CUTHBERT HARRISON, No. 84 Squadron, Royal Air Force, age 23, who was killed in an aeroplane accident on January 4 near Naziriyah, Iraq, was the third son of the late Edward Harrison and of Mrs. Harrison of "Ascot," St. Alban's Avenue, Bournemouth.

Killed

Flight Lieut. WILLIAM REGINALD CURTIS, R.A.F., who was killed whilst flying at Grain Experimental Air Station, on January 15, was the son of the late Capt. Wm. Curtis and Mrs. Emily Curtis, 63, Queensborough Terrace, W. 2. His age was 30.

Items

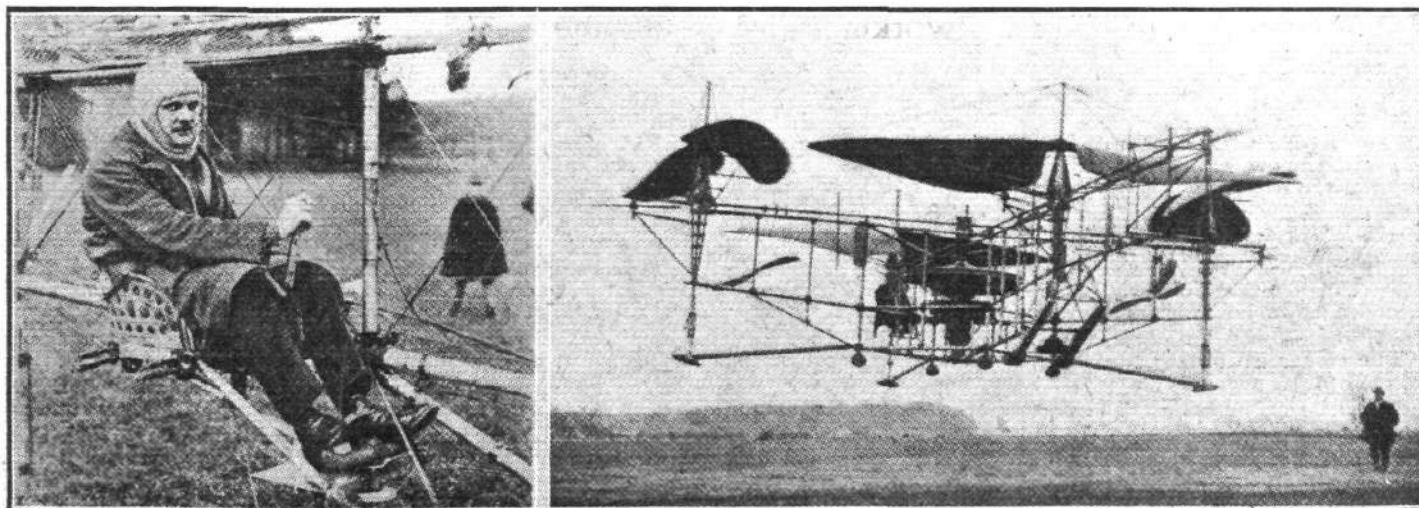
The Secretary of State for Air and Lady Maud Hoare entertained at dinner at 18, Cadogan Gardens, on January 10,

Sir Hugh Trenchard, Sir Geoffrey Salmond, Sir Walter Nicholson, Sir Vyell Vyvyan, Sir Ivo Vesey, Sir Sigmund Dannreuther, Air Vice-Marshal J. F. A. Higgins, Air Vice-Marshal Scarlett, Air Commodore J. M. Steel, Air Commodore Ludlow-Hewitt, Mr. McAnally, Mr. Bullock, and Captain Dobson.

The will of the late Major JOSEPH CLIFFORD GRIFFITHS, of Whitley Abbey Farm, Whitley Aerodrome, Coventry, manager and first pilot in the service of W. G. Armstrong-Whitworths Aircraft, Ltd. who was killed while testing a machine, has been proved at £2,312.

The funeral of Flight Lieut. E. W. NICHOLSON took place at Little Baddow, near Chelmsford, on January 17, with Air Force honours. He was 31 years of age, and had been on service in Mesopotamia. He died soon after his return home, from pneumonia.

Air Vice-Marshal OLIVER SWANN had the honour of being received by His Majesty on January 15, when the King conferred upon him the honour of Knighthood and invested him with the Insignia of a Knight Commander of the Most Honourable Order of the Bath (Military Division).



A SUCCESSFUL FRENCH HELICOPTER : On the left, M. Oehmichen seated in his helicopter, which, "as shown on the right, recently accomplished vertical and horizontal flights at Les Breuils. It covered a circular course, returning to its starting point at a height of from 10 to 15 ft.

MATERIALS IN AIRCRAFT CONSTRUCTION

By LESLIE AITCHISON, D.Met., B.Sc., F.I.C.

[In last week's issue of FLIGHT we published the paper read by Mr. J. D. North before the Royal Aeronautical Society on January 10, 1924, on "Materials in Aircraft Construction." This week we conclude with the paper on the same subject, and read on the same date by Dr. Aitchison.—ED.]

THE problems connected with the materials used in the construction of aircraft are very numerous, and the time available in one lecture is far too short to consider them in any kind of detail. It seems to be more appropriate to approach the matter broadly and to consider some of the basic problems with a little thoroughness than to examine a number of details in a superficial manner. The main objection that can be urged against this method is that the conclusions reached are by no means confined in their application to aircraft materials, but apply almost equally to most of the arts in which the same or similar materials are employed. After all, the aeronautical engineer is mostly concerned to obtain the ideal sample of any chosen material. This is due firstly to the fact that he subjects the materials to a higher duty, and secondly (what is really only a corollary to the first cause) he leaves a much smaller margin to cover what is known sometimes as the factor of ignorance and sometimes as the factor of unreliability, but what is (however named) the factor which represents the degree to which the material actually employed differs from the ideal sample of the material. The smallness of this allowance—the margin of manufacturing error—which is the distinguishing mark of aeronautical construction (as viewed by the metallurgist) is really a most important matter. The problem of aeronautical materials becomes in fact very largely the problem of how to minimise the dangers that arise from the narrowness of the margin permitted between the "ideal" and the average "real."

It must be said at once that only the metallic materials of aircraft construction are contemplated herein. These materials mainly comprise the following items:—

- Mild steel in the sheet form.
- Medium carbon steel—as cold drawn or hot rolled in bars—and as drop forgings.
- Strip steel of varying maximum strengths.
- Medium high tensile steel as sheet and bar.
- High tensile cold-worked bars, rods and wires.
- Duralumin as sheet, strip and forgings.
- Aluminium as sheet and strip.
- Steel, aluminium and duralumin tubes of various maximum stresses.
- Light alloy castings.

How can all these various materials be considered together, *i.e.*, as mere examples of one and the same problem? The only way is to find out what are the most common properties that are expected to be present in one and all. These would appear to be only strength and lightness, or what may be called generally specific strength, *i.e.*, the strength per unit mass. The plain consideration therefore becomes that of the properties that really constitute the strength of the materials as they are used. The best way in which the strength can be considered is to examine those properties that contribute towards strength, and then to see in what ways and to what extent these properties are affected by the other qualities of the materials—as manufactured, and as treated by the aero constructor. In the course of this examination it may well be found that the apparent paradox that "the stronger the material the weaker the part" is largely true.

Considering the metallic materials quite generally, it is fairly evident that the aero constructor views strength in various ways, and in fact utilises various mechanical properties of materials as criteria of the strength of different parts. At different times he appears to require the maximum stress, the elastic limit, the proof stress, the yield point, or the fatigue strength of the metal. With all these properties he yet calls for an accompaniment of high ductility and as great a toughness as possible. The reason for these last requirements will be considered later. At the same time the constructor is interested in the value of the Young's Modulus of the materials.

It may be of some advantage to devote a little space to these different properties in turn. The first to call for attention is the *maximum stress*. The values generally found in typical samples of the materials given above, supplied in accordance with B.E.S.A. specifications, are given in Table I. Side by side are quoted the strength/density ratios of the materials, these of necessity providing a sounder basis of comparison

for many purposes than the strength/area ratios usually quoted.

Material.	Max. stress tons/sq. in.	Max. stress/ density.
Mild steel sheet	26	3.30
Medium carbon steel	36	4.60
Cold-drawn steel	36	4.60
Medium tensile steel strip ..	52	6.62
High tensile steel strip	76	9.70
Medium tensile steel bar	55	7.0
High tensile cold-worked steel ..	78	10.0
Duralumin	27	9.6
Aluminium	10	3.67
Soft aluminium	6	2.22
Light alloy castings	10	3.40

The figures in the table call for little comment, showing as they do a range of maximum stress from 6 to 78 tons and a strength/density ratio between 2.2 and 10.0. It may be asked quite legitimately why the maximum stresses for each material are limited in the way indicated by these figures. This question very often receives its best answer on practical grounds, though it must be admitted that in some instances the practical reasons are prejudices sanctified by prolonged observance, and that they cease to be good reasons when examined impartially.

Even so there is some quite reasonable ground for the particular values of maximum stress that are quoted, and in quite general terms it may be said that the values chosen are those that with a given metal are accompanied by the most satisfactory ductility and toughness. This statement applies perhaps more particularly to steels than to the other materials, but is true of all metals in a greater or less degree. To indicate this briefly the test records given in Table II and Fig. 1 for a typical steel may be referred to.

Hardening Temp. °C.	Tempering Temp. °C.	Max. stress tons/sq. in.	Elongation per cent.	Red. area per cent.	Impact ft. lb.
830	—	114	13	28	12
830	300	96	13	40	5
830	400	83	14	47	7
830	500	73	17	52	35
830	600	63	21	59	55
830	650	59	23	63	67
830	700	71	13	40	29

These tests clearly show that at a certain maximum stress, *i.e.*, 59 tons, the ductility and toughness of the steel are at a maximum. With this particular steel, then, the *most suitable* maximum stress is clearly 59 tons/sq. in. The same kind of information could be shown for other steels, which leads to the definite conclusion that for any particular steel the best condition is produced by such and such a heat treatment, which in turn fairly definitely fixes the maximum stress (and incidentally the concomitant ductility and toughness). Conversely it can be said that for any particular maximum stress there is a particular steel, heat treated in a particular way, that gives this maximum stress most suitably. The variation in the other properties of a number of steels, all heat treated to give the same maximum stress, are shown in Table III, where the superiority of one particular steel as regards ductility and toughness is manifest. It is a sound rule to work upon that an alteration in maximum stress is better obtained by the use of a different material than by an alteration in the treatment of the same material, for the same material cannot very well have two best conditions.

Heat treatment of steels (all different).	Max. stress tons/sq. in.	Elongation per cent.	Impact ft. lb.
Air-hardened 820°C., tempered 500°C. ..	76	16	32
Air-hardened 820°C., not tempered ..	73	14	7
Oil-hardened 850°C., tempered 400°C. ..	77	17	14
Water-hardened 850°C., tempered 400°C. ..	75	14	11
Water-hardened 870°C., not tempered ..	77	10	3
Water-hardened 860°C., tempered 500°C. ..	74	16	10

The same considerations apply to the light alloys, however they are hardened. At a certain value of maximum stress

the best values of ductility are obtained by using a certain material in a certain way. The range of combinations is not so wide as with steel, but a fairly large variation may be induced by differences in the amount of working. This process should be very carefully and strictly controlled, as otherwise maximum stress will be obtained at the expense of other equally valuable properties.

Whilst dealing with maximum stress it may be pointed out briefly that hardened and tempered steels are the most suitable to give useful values of this property. Higher values are usually produced by hardening either by quenching or by cold working, and both these processes reduce the ductility and toughness. Consequently the brittleness of quenched steel should be reduced by tempering—at the highest convenient temperature—whilst the brittleness of the worked materials should be reduced by limiting the amount of work-hardening as much as possible. The effect of varying amounts of cold work upon both the strength and the ductility of a typical material can be seen in the values shown in Table IV and the curves in Fig. 2.

The *elastic limit* of metals is a very variable proportion of the maximum stress. For the typical materials quoted above the values of this property are shown in Table V, together with the ratio between the elastic limit and the density, and also that between the elastic limit and the maximum stress. The variations are obvious both in the absolute values and the ratios.

It is to be remembered that hardening a metal, either by quenching or the application of cold work, generally reduces the ratio between the elastic limit and the maximum stress, and that this ratio can be recovered and often actually increased by subsequent reheating. All steels that have been hardened should therefore be reheated to temperatures of at least 350°C. The quenched steels should be tempered at higher temperatures than this for other reasons (ductility and toughness), but if the work-hardened steels are heated beyond 450°C. they lose the strength imparted by cold working.

After quenching and tempering, or work hardening and blueing, the ratio of elastic limit to maximum stress of all metals is markedly higher than in the same metals when normalised. The same thing applies to the light alloys when cold worked and reheated to relatively low temperatures. This can be appreciated from a reference to Table VI.

Table IV (Aluminium Sheet)

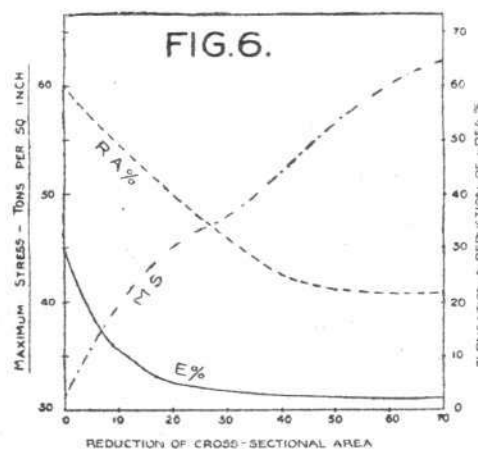
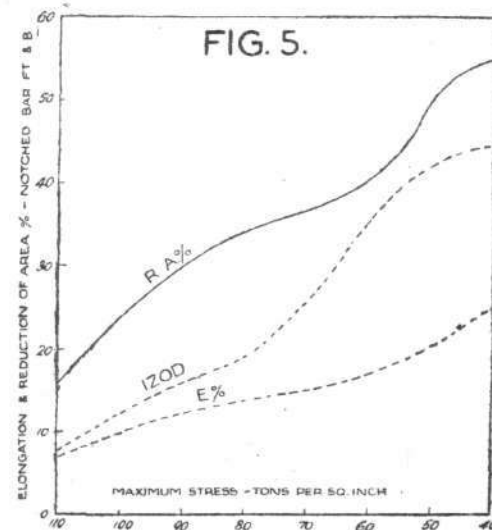
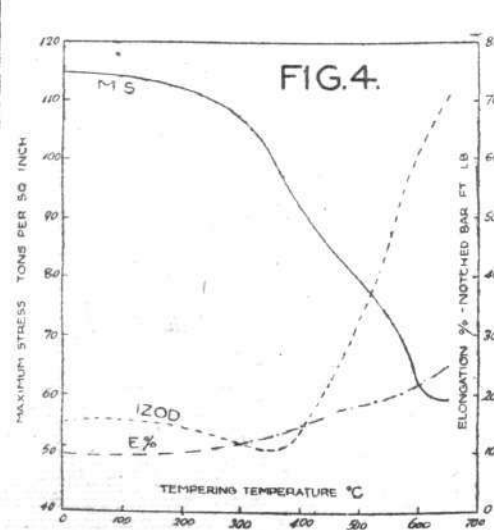
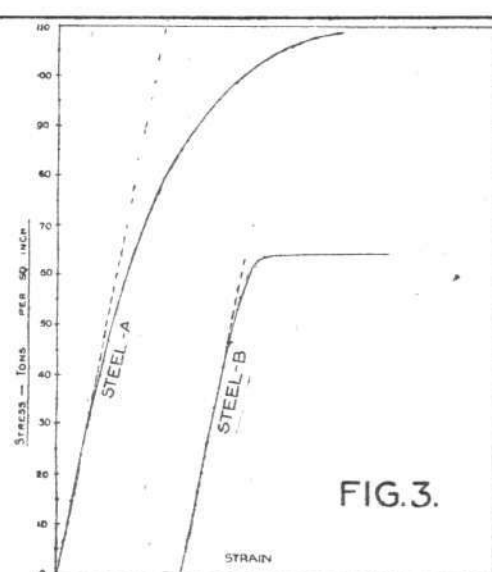
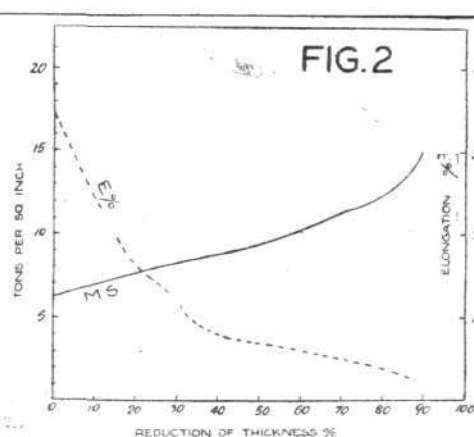
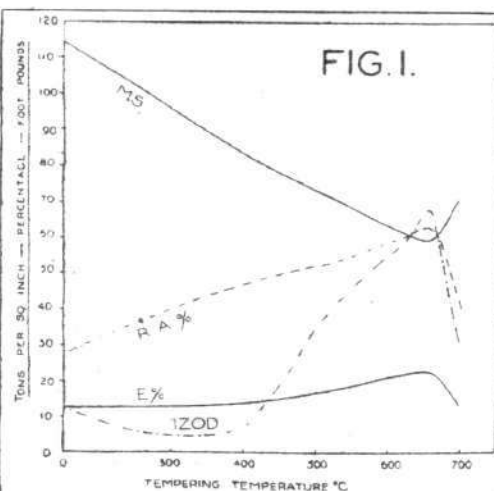
Reduction of thickness per cent.	Max. stress tons/sq. in.	Elongation per cent.
—	6.2	35
10	6.9	25
20	7.5	16
30	8.2	12
40	8.9	8
50	9.6	7
60	10.5	6
70	11.5	5
80	12.4	4
90	15.0	2

Table V

Material.	Elastic limit tons/sq. in.	Elastic limit max. stress.	Elastic limit density.
Mild steel sheet ..	13	0.50	1.65
Medium carbon steel ..	18	0.50	2.30
Cold-drawn steel ..	27	0.75	3.35
Medium tensile steel strip ..	35	0.67	4.45
High tensile steel strip ..	50	0.66	6.4
Medium tensile steel bar ..	35	0.64	4.45
High tensile cold-worked steel ..	25	0.32	3.20
Duralumin ..	15	0.58	5.30
Aluminium ..	7.5	0.75	2.77
Soft aluminium ..	2.5	0.42	0.93
Light alloy castings ..	4.0	0.40	1.38

Table VI

Condition.	Elastic limit tons/sq. in.	Elastic limit max. stress.
Normalised ..	22	0.55
Worked not blueed ..	24	0.39
Worked blueed 100°C. ..	32	0.55
Worked blueed 200°C. ..	38	0.67
Worked blueed 300°C. ..	45	0.75
Worked blueed 400°C. ..	42	0.72
Worked blueed 500°C. ..	37	0.71
Worked blueed 600°C. ..	28	0.70



The proof stress of metals is not without its controversial aspect. In these present remarks it may be as well, therefore, to say that the property is taken to be the stress that produces 0.1 per cent. strain greater than the elastic strain produced by the same stress, assuming that E is the same at this stress as at stresses inferior to the elastic limit. The variations in the value of this property can be seen from Table VII, in which are shown not only the proof stress but the proof stress/density ratios and the proof stress/maximum stress ratios of various typical metals.

Table VII

Material.	Proof stress tons/sq. in.	Proof stress max. stress.	Proof stress density.
Mild steel sheet ..	16	0.62	2.05
Medium carbon steel ..	22	0.62	2.80
Cold-drawn steel ..	30	0.83	3.82
Medium tensile steel strip	42	0.80	5.35
High tensile steel strip ..	57	0.76	7.3
Medium tensile steel bar ..	40	0.73	5.1
High tensile cold-worked steel ..	40	0.52	5.1
Duralumin ..	16.5	0.62	5.9
Aluminium ..	8	0.80	2.95
Soft aluminium ..	3	0.50	1.11
Light alloy castings ..	5	0.50	1.73

Substantially it may be said that the rules that apply to the elastic limit apply equally to the proof stress, though perhaps not in quite the same degree. Nevertheless, it is of importance to appreciate that the reheating of hardened materials is necessary in order to induce the highest ratio of proof stress to maximum stress.

A further point of the same kind is to be noticed in regard to the ways in which the other properties may vary in two materials having the same proof stress. In Table VIII are shown the complete tensile properties of two steels having substantially the same proof stress. These are decidedly different. The difference is just as great and perhaps more obvious in the stress/strain curves of the two materials as set out in Fig. 3.

Table VIII

	Steel A quenched and tempered.	Steel B worked and blued.
Proof stress tons/sq. in. ..	64.5	62.9
Elastic limit tons/sq. in. ..	24.1	41.9
Max. stress tons/sq. in. ..	110.5	63.8
Elongation per cent. ...	12.0	11.5
Red. of area per cent. ..	28.0	27.3

If they show nothing else, the values in Table VIII and the curves in Fig. 3 indicate plainly that the quotation of the proof stress is by no means an exhaustive definition or a precise statement of the mechanical properties of a metal.

So much has already been said about the fatigue strength of metals, and so much more is likely to be said before the process of fatigue is wholly defined and understood, that no useful purpose would be served by discussing the property as a property. It must be sufficient to quote the actual values that have been obtained upon various metals.

These values all represent one set of conditions, i.e., equal plus and minus stresses, and a representative set of such values are given in Table IX

Table IX

Material.	Fat. range tons/sq. in.	Fat. range max. stress $\times 2$	Fat. range density.
High tensile alloy steel ..	± 41	0.50	10.4
Medium tensile alloy steel	± 28	0.50	7.1
Medium carbon steel ..	± 17	0.45	4.3
Cold-worked steel ..	± 16	0.42	4.1
Mild steel ..	± 12.4	0.42	3.1
Duralumin ..	± 10.5	0.41	7.44
Light alloy castings ..	± 3.0	0.30	1.94

In the same table are given the ratios of fatigue range to the maximum stress, and also the ratios of the fatigue range to the density of the various metals referred to.

One of the singular things about the fatigue strength of metals is their almost complete independence of all the other mechanical properties of the materials. It seems to be established fairly definitely that the highest ratio of fatigue range to maximum stress is found in the metals having the lowest maximum stress. It is certain that this ratio is lower in hardened metals than in the same metals after the hardness

is reduced. (This really refers chiefly to steel and iron. Soft iron gives the highest ratio in this class of metal. The variations with other metals are not so easy to demonstrate.)

Time is not available for an investigation of the way in which the fatigue range of a metal is affected by variations in the relative magnitudes of the component stresses of the range, but it is not wise to omit all reference to the fact that the fatigue range of a metal (even under equal plus and minus stresses) is affected greatly by its condition. Cast metal gives a much lower value than the same metal when forged. Also a steel that is tested so that the fatigue stresses are applied parallel to the grain of the metal has a higher fatigue range than the same metal tested so that the stresses are imposed at right angles to the fibres.

The very notable variations in the actual values of the fatigue ranges of materials under different conditions makes it very necessary that a conservative estimate should be made of the resistance of any metal to fatigue stresses. They also indicate the need of intense caution in accepting any particular margin of safety that is based upon an assumed value of the fatigue range, which may be correct for one set of conditions.

Without claiming too much accuracy for the generalisation, it may be suggested that in the steels used in aircraft it would be reasonable to take ± 40 per cent. of the maximum stress as representative of the fatigue range in "longitudinal" specimens and about ± 30 per cent. in "transverse" specimens. For light alloys both of these values ought to be reduced by about one-third. Doubtless there are many, if not a majority of, instances in which it is scarcely possible to diagnose the condition of a particular part and to say that the stresses (in so far as they are fatigue) are applied in the longitudinal or the transverse direction exclusively. In most instances it would appear wisest therefore to assume that the transverse conditions hold, and to calculate the factors of strength accordingly.

The values given above are of course those obtained in tension and compression. The torsion values are less than the tension, but generally appear to be less by a definite proportion, being usually round about 60 per cent. of the tension values in so far as they have been determined.

By means of such figures and considerations as those given above, it seems likely that the strength values of the various aircraft materials may be regarded as well covered. The values given, however, are more or less the "ideal" values, and the "real" ones may be quite appreciably different from the "ideal." What amounts to much the same thing in the end, though it is scarcely the same thing in appearance, is that in very many instances these ideal values, even though present in the materials, are not realised in practice. The "real" values are apparently much below the "ideal."

The general reason for this discrepancy may be stated briefly to be found in the local imperfections of the metal. This diagnosis is certainly bound to appear as an anti-climax but the term imperfections is a very general one and covers a wide variety of different types of defect. These may be inherent to the metal or may be introduced during the manipulation of the metal by the constructor.

Before dealing with some of the more potent members of the family called imperfections it may be well to refer to the important properties of toughness and ductility. The precise nature of those properties cannot be entered upon, but a few remarks about them are really very necessary. For the present purpose at least they can almost always be regarded as related to one another. There are cases in which ductility, as ordinarily measured, may exist in the absence of toughness, as ordinarily measured; but I know of no case in which toughness exists in the absence of ductility (even as ordinarily measured). Looking at the problem in another way, it may well be thought that toughness is nothing but an expression of an effective ductility. Without ductility a metal cannot be tough, and if the material has ductility under certain conditions, but is so lacking in toughness that it cannot make use of its ductility, it might as well be non-ductile. Supremely, therefore, a metal requires toughness, as this property brings with it ductility, and, what is more, the power to make effective use of its ductility.

Toughness and ductility as ordinarily expressed in metals are generally inversely proportional to the strength values as ordinarily stated. Harden a metal, either by working or by quenching, and down go its toughness and ductility. Even by taking a variety of compositions of steel—suited to give a variety of strengths—the same general results are obtained, namely, that the higher the strength the lower the ductility and the toughness. This is evident from the curves in Figs. 4, 5 and 6.

It is also sometimes possible to increase by heat treatment the ductility and toughness of a metal that is fully hardened

in such a way that its maximum stress is not materially decreased. Examples of this are shown in Table X.

Table X.

Condition.	Max. stress tons/sq. in.	Elongation per cent.	Red. of area per cent.
Work-hardened	72.0	5	18
Work-hardened and blued	72.9	10	37
Quenched	115	4	13
Quenched and tempered ..	113	10	31

The final remark that should be made regarding toughness and ductility is that both are affected materially by the condition of the metal. Cast metals have lower ductility and toughness than the same metals when forged, and the values of these properties "longitudinally" are markedly higher than the values "transversely," although the strength factors remain unaltered. This point is adequately illustrated by the figures given in Table XI taken from one and the same metal.

Table XI

	As cast.	Forged (longitudinal).	Forged (transverse).
Elastic limit tons/sq. in.	16.4	20.1	18.9
Max. stress tons/sq. in.	38.3	36.0	36.0
Elongation per cent. ..	19.7	33.1	23.5
Red. area per cent. ..	25.8	58.7	43.5
Impact ft. lb.	16	86	29

(It is not without significance, I think, that the fatigue range is affected in much the same general way as the ductility and toughness, although the other strength properties remain unaffected.)

It seems reasonable then to draw the conclusion that ductility and toughness are increased by processes that soften a metal and reduced by processes having the reverse effect. Also they are improved by homogeneity (in the microscopic sense), and by the greatest freedom from the disturbing effects of fibres and the like. These conclusions have been drawn here because they must be applied to many examples of the disparity between "ideal" and "real" strength values.

Some of the "imperfections" can now be examined. One of the most potent is the group including slag, non-metallic inclusions, and the like. All these constituents of metals have their origin in the metal-manufacturing process and grossly affect the ductility of the metal, particularly when the ductility is called upon to operate in directions perpendicular to the slag streaks. In this direction the ductility is so much reduced by inclusions that a metal can rarely flow as much as is expected of it. Failure to flow is generally but another way of saying that the metal breaks—a thing that occurs very frequently in the forming of spar sections from metal strip.

Roaks and contraction cavities that are rolled or drawn out to notable lengths are also metallurgical in their origin, but should really be classed with such imperfections as cracks, splits and jagged edges in holes, rough machine marks, tears made during punching and riveting, and such like defects. It has been well established that the presence in a metal of any such defects affects very markedly the distribution of stresses within the metal. The general net effect is an adverse one, and operates by markedly increasing the stress value in the part at the position of smallest radius in the imperfections mentioned. A roak or a contraction cavity can scarcely be distinguished from a ragged tooling mark or a tear around the periphery of a rivet hole, except that the profile is generally rather smoother and the liability to stress concentration rather less. It must be very evident, therefore, that all in this class of imperfection are likely to be specifically harmful and to bring down the real strength of a part so materially as to constitute a notable menace to the safety of a machine for which the calculations have been made without taking such possibilities into account.

This is the point at which the toughness and ductility of the metal definitely may come into operation. When a stress is applied to a part, and, by reason of notches or the like, it is unevenly distributed so that it has its maximum intensity at certain positions, the excess of the actual stress at these positions over the assumed mean stress in the part may be sufficient to cause the actual stress to exceed the elastic limit of the metal materially. Granted that the metal has sufficient effective ductility, it will flow at the position of highest stress and will flow in such a way as to reduce the intensity of the stress at the considered point. In order to reduce the stress to a value lower than the elastic limit of the metal, quite a considerable flow may have to occur within the small element of metal that is actually subject to the abnormally high stress. This amount of flow can only

occur in metals that possess adequate ductility and toughness. Unless the requisite flow occurs, fracture is almost sure to ensue, and in fact to intervene before the stress is reduced to a harmless value.

The importance of the presence of the necessary ductility is manifest. Consider two pieces of metal—one having half the ductility of the other. In many instances this might well mean the less ductile metal having approximately twice the strength of the other. In the ordinary way the mean stress on the parts might be expected to be in general proportion to the maximum stress. The concentrating effects of the defect take no account of actual maximum stress, so that the local stress in one will be twice that in the other. In order, therefore, for the reduction of the magnified stress to come about by the flow of the metal, the same amount of plastic distortion must occur in both metals. With the more ductile metal the flow may occur and a satisfactory readjustment be brought about. With the less ductile metal this does not occur because the requisite ductility is not available, and before safety is reached the fracture of the metal occurs. This is a parallel case to that of Mr. Micawber's famous balance sheet, but is also a very good example of the paradox that "the stronger the metal the weaker the part."

The methods by which an adequate ductility can be ensured have been indicated already, and need not be repeated. The main things to remember are that reheating after hardening is of great value in raising the ductility and toughness of a metal, and that for any given maximum stress (proof stress or the like) a certain combination of chemical composition and heat treatment brings about the highest accompanying ductility and toughness.

Besides the causes already mentioned that reduce the strength of a part, one other, namely, corrosion, must be considered. This process has two effects. Firstly it may generally reduce the strength of a part, but this effect is relatively unimportant. Secondly it may reduce the strength of a part very locally by the formation of a corrosion pit or a corrosion notch. Such defects will have all the bad effects of the other kinds of notch, and at the same time may be more insidious, as they are unsuspected because of their non-existence at the time that the part was made and inspected. It is clearly, therefore, amongst the less ductile metals that immunity from corrosion is likely to be of the greatest importance and value.

A further type of imperfection is one that is very frequently overlooked. This is the type known as internal strain or internal stress. Of this type of trouble a good deal has been written at one time and another, and those interested can consult the original writings. The presence of stresses within many parts bearing no external load is very well proved, and the magnitude of the stresses can be gauged from the fact that they are frequently sufficient to fracture a part that is standing quite idle. Usually, if not inevitably, such fracture occurs only in those parts in which there is a notch or corner that may act as a localiser for the stresses, but even so the average magnitude of the internal stress that will cause the spontaneous fracture of a die block weighing half a ton is by no means small.

The most prolific source of internal stresses is hardening—either by quenching or by working—and the former is usually the more potent. In most instances the immediate cause is merely the uneven rates of cooling of different portions of the same article. This may sometimes occur even where there is no deliberate intention of hardening, a good example of such being in welding, whether of plain carbon steels or alloy steels. The only cure for the welding trouble is a reheating of the whole article followed by regular and even cooling. For the internal stresses due to hardening the best cure is a tempering treatment at a fairly high temperature. This operates in a dual way, firstly by reducing the differences of volume that cause the stresses, and secondly by increasing the ductility and so making the flow of the metal more probable than its fracture.

The need of such a treatment is very obvious. If a part is already under stress, the further stress that can be put upon it without fracture can (in certain directions, at least) hardly be greater than the difference between the existing stress and the maximum stress of the metal. The mere existence of the internal stress consequently very materially reduces the real strength of the part below that indicated by the ideal strength that is expected of the metal that composes it. As the incidence of high internal stresses is most frequent in metals of fairly high maximum strength, the intrinsic weakness of many parts made of "strong" metals is once again manifested.

The points that have been raised in the course of the above remarks have been intended to illustrate the ways in which

the disparity between ideal and real values may arise. As stated at the beginning, these causes are not entirely unique to aircraft material, but become of greatest importance in this aircraft because of the smaller margin allowed for such like defects. Granted the existence of the defects or imperfection, the question arises at once as to whether the margin provided is sufficient to be safe. No simple answer can be given to this question. For some materials and under certain conditions the answer would be easily the opposite of that for other metals in other conditions. What is certain is that in general it is none too great, taking all in all.

A second question naturally arises when it is asked how may the margin be made most effective—or (what amounts to much the same thing) how may the defects be rendered most ineffective. Again there is no golden gospel that preaches salvation for all cases, but certain beneficial lines of action have been indicated earlier. In the first place, it is a very good rule to decide that a material shall be used only in that state in which it possesses the most satisfactory combination

of maximum stress and ductility. There are definite limits to the possibilities in respect of both types of property, and these should be carefully respected. High maximum stress in the absence of adequate ductility does not constitute strength, but weakness. Hardened metals—whether hardened by working, as in aluminium, or by quenching, as in alloy steels—are not ductile or tough. The values of both properties can, however, be markedly improved by reheating the metal to suitable temperatures. The most suitable temperature depends upon the nature of the metal, the type of hardening, the degree of hardening, and the purpose to which the part is to be put, but it is a good and sound rule to make the reheating temperature as high as possible. Besides its direct effect upon the toughness and ductility of a metal, this process also has decidedly beneficial effects upon the elastic limit, proof stress, fatigue range and freedom from internal stress. For the purely metallurgical defects such as inclusions, nothing need be said here, as the aircraft constructor cannot do anything practical with them that has any remedial effect.

REMINISCENCES OF THE EARLY DAYS OF AVIATION AT BROOKLANDS*

IN 1919 I was travelling from London to Cambridge. An R.A.F. pilot, who was looking out of the window of the dining car, remarked on the curiously-shaped piece of water we were passing. I looked out, and saw that we were passing the flooded Lea Marshes. My thoughts went back to ten years before, and the work which was done on this marsh by Mr. A. V. Roe and his assistants.

All this pioneer work is now largely forgotten. The memories of those days of hard work and high hopes, some of the hopes fulfilled and some of them disappointed, made me consider that it would be well that I should write them down while still fairly fresh in my mind. As I thought of the men who had done the work, I began to realise that most of them had paid the penalty of pioneers, and could never relate their memories. So I am endeavouring to tell you of those days, drawing on memory only, and not referring to any periodicals or diary. If, as a result, I omit the work of any pioneer or cast a slight on the work of anyone, I ask indulgence. All memories are apt to be distorted by time, and events take a personal perspective instead of historical sequence.

On July 13, 1909, Mr. A. V. Roe made a hop of about 100 ft. length on his triplane fitted with a 9 h.p. Jap motor-cycle engine. This was the first flight on an all-British aeroplane. Two days later this was repeated, and a photograph of the flight was published in the *Daily Mail* of the following day. It was not much of a flight: just a hop with a minor crash, but it was a beginning. The triplane was a curious construction showing much originality, and more nearly resembled modern machines than did any other aeroplane of that date.

The Lea Marshes was far from being an ideal aerodrome. The ground was divided by three fences. The two parts near the railway arches, which served as hangar and workshops, were covered with stumps of wood, used to tether donkeys and goats. The further portion was of fair surface but small, probably about 10 acres, and was bounded on two sides by water, on the other sides by Lea Bridge Road and a fence.

Those were days of toil. Every hop meant a crash. The procedure was as follows. At 4 or 5 a.m. we assembled and carefully wheeled the triplane out of the railway arch down the tow-path beside the River Lea—a difficult job, as there was a small gate to pass through, and the tow-path was narrow. Having pushed the triplane to a suitable corner of the ground, amid the jeers of the onlookers, we endeavoured to start the engine, which usually took 15 minutes. Mr. Roe, having given the word "Let go," all his assistants seized tools, pieces of timber, and other appliances, to repair the inevitable smash. One kept a cycle and a fire extinguisher handy, and followed as close as possible in case of fire, which was not infrequent. When the landing took place after a hop, which might be anything from 10 to 120 yards, if a miracle had occurred and the machine was still intact, the process was repeated until the inevitable crash took place. We then partly dismantled the triplane and carried it home, amid further jeers from the onlookers. Then work started, and we worked for days in the very damp and dark railway arches to prepare for the next crash. The average programme was two weeks' work, a 50-yards hop, crash, and work again. At first no one with any sense stopped to watch the madmen, but after M. Blériot had crossed the Channel we had another

difficulty—that of sightseers. On one occasion the trams and buses were stopped and the police complained, so Mr. Roe had police persecution added to his other difficulties.

The story of Brooklands aerodrome commenced with Mr. A. V. Roe's attempts in 1908, but the first real flights were made by Paulhan in October, 1909, and shortly afterwards the aerodrome commenced its activities, with Messrs. Astley, Lane, and Neale. Mr. Raynham came to the aerodrome to learn construction in December, 1909. The original sheds had no windows, so we had to take the shutters down for light, and during the cold winter we had an old bucket with a coke fire to warm the handles of the tools. It was an awful time: mud floor, leaky roof (we used the sheds before the roofs were finished), cold, long hours and floods. However, the coke fire cheered us a lot, because the smoke made us think it was warm.

The Lane monoplanes were a very promising type, well made and of fair design. The chief point of note was the undercarriage. The wheels were in forks, which allowed them to track and also move fore and aft, this latter motion giving the shock-absorbing vertical motion. It was not unlike the front forks of a Triumph motor-cycle reversed. These monoplanes had biplane tails, the lower plane fixed and upper plane hinged to act as an elevator. The results were rather poor on account of interference. However, I saw some good flights with these.

The first aeroplane designed and built at Brooklands was the Neale "Pup," a monoplane of 29 ft. span and 5 ft. chord with aileron control. The engine was a 9 h.p. Jap without auxiliary exhaust posts, and was geared down 3½ to 1 with a spur gear, so the propeller shaft lay on top of the crankcase between the cylinders. The motor unit was heavy—about 14 lbs. per h.p. The whole machine, with Mr. Raynham in the seat, and petrol and oil for two hours, weighed 450 lbs. The factor of safety was high—probably about 7, but the undercarriage—on the lines of a Blériot—was weak. The planes had too little camber—about 2 ins. for the under surface and 6 ins. for top surface, with a parabolic curve drawn by eye from a small drawing. This gave 45 lbs. per h.p., 3½ lbs. per sq. ft., which, with the inefficient camber, prevented sustained flight. The streamline was good, so the machine could be got off the ground without trouble, but it sank back to earth after a short hop.

By Easter, Brooklands was a very busy place. The Petre Brothers brought their monoplane, which was a marvellous piece of construction. The fuselage, spars and ribs were of lattice-girder construction, riveted together with copper boat nails and rooves, the material being ash and swamp elm, no wires being used except for external bracing. The construction was light and rigid; the cross-sectional areas were insufficient to take the compression forces, hence it was not strong. It was unsuitable for experimental use, because a slight smash strained every joint. The outstanding feature was the position of the engine and propeller. The engine was just between the main spars, driving a long shaft of 2-in. 16 s.w.g. tube with universal joints at each end, to the propeller in the tail. As the tail skid was long, to protect the propeller and fix the height of the tail, the angle of the main plane was variable. The pilot sat in front. This monoplane was engined with a 40 h.p. N.E.C. two-stroke engine, which gave much trouble and little power—probably about 25 h.p.

* Abstract of paper read by Mr. R. L. Howard-Flanders, before the Institution of Aeronautical Engineers on January 11, 1924.

The first Martinsyde monoplane was there, a small Antoinette type machine with an eight-cylinder J.A.P. engine. This was the forerunner of the well-known Martinsyde aeroplanes, and was nicknamed "the little oil bath," because the auxiliary exhaust ports let the castor oil escape from the crankcase on to the pilot's face at the rate of 2 gallons per hour.

A very interesting monoplane, the Grégoire "Gyp," was housed in shed No. 7. It was a single-spar machine, with the spars pivotted on the top of the fuselage, and by means of a pair of bevels, somewhat on the lines of a motor-car differential, the relative incidence of the wings could be altered for lateral balance. The engine was a four-cylinder, water-cooled Grégoire motor, run in an inverted position. It seemed to run very well and without undue lubrication troubles. This machine, like so many of the early attempts, was never re-built after its first flight, which also meant its first crash on landing. The Blue Bird restaurant opened in this shed about Whitsun.

Shortly after Easter the Howard T. Wright Company appeared in shed No. 9 with Mr. Boyle's "Avis" monoplane, designed by Mr. W. O. Manning, 28 h.p. Anzani fan-type engine, with cruciform tail universally jointed forming rudder and elevator. This monoplane made some fine flights of 30 minutes or more—a great feat for those days.

The Humber monoplanes were housed in sheds Nos. 4 and 5. They were of Blériot type. Some were fitted with an improved type of engine similar to the Fan Anzani; others with Clerget-type, water-cooled motor (four vertical cylinders, copper water jackets, overhead valves with concentric push-rods, dimensions about 110 by 130 mm.). Both of these motors were built by the Humber Company, and ran better than any engines of that date. Mr. Barnes, the racing motor-cyclist, obtained his ticket on one of these. It is a pity the Humber Company gave up aviation, because they were just getting over the preliminary difficulties when they closed this branch.

Several large motor and engineering firms, both in England and France, burnt their fingers in 1910-11. When M. Blériot crossed the Channel they thought aviation was perfected, whereas it was not even at the half-way house, so, without considering the fact that they had to train a personnel and feel their way, they launched out with a large expenditure, often controlled by unscrupulous men, and then wondered why there was no return.

Messrs. Blondeau and Hewlett first arrived at Brooklands in this summer, and everyone was astonished at the hard work Mrs. Hewlett did on their Farman biplane. Without any doubt, Messrs. Hewlett and Blondeau earned their success by hard work and method. Their shed was always tidy and always busy. Brooklands grew steadily, and the community of workers increased. We were all poor and all good friends. This part of the Brooklands life must include Mr. V. Hammond, who worked in a little shed of felt and rough timber, and built what was probably the lightest triplane ever made. All metal work was lightened out with holes regardless of the labour entailed, and all these holes were drilled with a hand brace. I was very sorry when engine failure brought this venture to an end. The engine was a four-cylinder Vee, which appeared to give absolutely no power at all. Mr. Roe put up some fine flights on his triplanes during this summer, and he began to get pupils and form the successful school which during the next year turned out several well-known pilots, such as Messrs. Raynham, Pixton, etc.

Later on in the year Mr. Sopwith gained his ticket on his Howard T. Wright monoplane, and afterwards flew his H. T. W. biplane which he took with him to America next year and won many prizes. Both these machines were designed by Mr. W. O. Manning, who was a frequent visitor to Brooklands. Mr. Sopwith had a pet bear which used to escape the vigilance of its keeper and get into other people's sheds in search of tins of condensed milk.

The year 1911 at Brooklands was entirely a year of expansion; sheds were built, reaching the number of forty by the end of the year, and the aerodrome was gradually improved. When the first sheds were built the ground was full of ditches and hedges, and the only decent piece of ground extended from the sewage farm corner to just beyond shed No. 9, and was about 100 yds. wide. Between the sewage farm corner and the paddock there were deep ponds where the earth had been dug to make the track. There was also a farm house and a barn. The river made several bends in the aerodrome, and there were several more pits or ponds at the south end of the ground. An army of men worked all this year and right up to the end of 1911 levelling the ground and diverting the river. Practically every inch of the present aerodrome has been dug and levelled by hand. In 1910 the ground was bare, sandy earth, but grass grew in the autumn.

Mr. Dashwood Lang was busy with propellers which seemed to develop from a toy boomerang which he was making for Gamages. These early propellers gave good results, and soon showed themselves superior to the best French propellers. The feeling of general good fellowship among the workers on the aerodrome began to grow, and we were all good friends, like a large family without any serious disputes, using each others' tools and generally borrowing and lending everything, including advice.

The next year, which was perhaps the most eventful year that aviation has ever seen or will ever see, opened with some fine flights by Mr. Pixton on the Avro biplane fitted with a 35 h.p. Green engine. It is interesting to note that this was the same engine which was flown to Brussels in 1919, and subsequently to Rome, after eight years' use—a good record for any engine. One of the interesting early machines which came to Brooklands in 1911 was the Weiss monoplane—an automatically stable machine without a tail-plane. The planes had a very heavy top camber, with back and upswept tips, something like a duck's wing.

The Hanriot school was in full swing early in 1911. The pupils who learned on the old "Henrietta" were Messrs. England, Fisher, Bell, Henry Petre and Gnosspelius. This monoplane had one peculiarity which seems to have been unique, in that it could be flown *cabré* without becoming unstable; when too *cabré* it simply subsided gently to earth without sideslip. It was not a suitable pupil 'bus, because the boat built half round the fuselage was so difficult to repair.

It was during the spring of 1911 that the A.B.C. Engine Co. started in the small works on the aerodrome, with their four- and eight-cylinder water-cooled engines very similar to the Curtiss. Mr. Macfie was down on the aerodrome with his biplane fitted with 50 h.p. Gnome on which Messrs. Macfie and Valentine gained their certificates. There was great excitement at the time of the circuit of Europe. On the return flight from Hendon Mr. Valentine landed at Brooklands and abandoned the race so as to get his machine tuned up for the circuit of Britain.

The next event of note was, of course, the circuit of Britain. Owing to the high entrance charge on the day of the start, many young enthusiasts came in the day before and slept in the sheds. As far as I can remember, there were ten in my shed. In the early morning we went out to witness the preliminary trials of some of the new arrivals. One of the machines began to lose pieces of plane in the air at about 400 ft., and came to earth gradually breaking up. The final smash was comprehensive, the whole biplane was packed up in small packing-cases without the need of any more breaking or cutting on the part of the volunteer packers. Three cylinders of the E.N.V. motor were torn off the crankcase. Strange and happy to relate, the pilot Mr. R. Kemp, was uninjured, except for a slight cut.

The extraordinary Etrick monoplane caused much interest. It was an all-steel contraption with single-surfaced planes. The tips were bent back and upswept, and were flexible, with a kingpost and umbrella-like bracing. The planes were braced with a biplane bracing, having the lower spar exposed. The whole machine was a mass of wires and head resistance. It had a real 120 A.D. motor, and the general noise and thrust from its propeller impressed us all. It failed at Luton, but I don't remember why. The start was rather late in the afternoon, and the heat was intense. Most of the competitors started from the north end of the aerodrome. Lieut. Porte, on his Dep., had a smash when starting. Many competitors, including Mr. Gilmour, could not get off in the heated air. Those who did manage to get off went several miles south to find better atmospheric conditions before they turned. Mr. Cody, following his usual custom, however, waited until the air was somewhat cooler, and flew straight to Hendon, only clearing the telegraph wires over the railway line by inches. So ended one of the most noteworthy days of British aviation. During the circuit Brooklands was rather quiet till the arrival of Mr. Beaumont, the winner, who was welcomed by everyone. After three such exciting days the remainder of 1911 was quiet.

1912 opened with the bugbear of commercialism beginning to destroy the feeling of good-fellowship. Nearly everyone was hoping to make money, and some were beginning to spend it. The Heath Club became the headquarters instead of the "Blue Bird," and billiards became the evening occupation instead of working till bed time. This was the year in which so many of the Old Brigade lost their lives—Messrs. Astley, Gilmour, Fisher, Johnstone, Petre, and others—all from the good company of Brooklands. It was altogether a bad year, with the worry of trying to get a financial backing, and the question—Will the Government really assist, or is

their talk mere dope? The outstanding aeroplane of the year was Mr. Sopwith's American-built Wright biplane fitted with a 40 h.p. A.B.C., piloted by Mr. Hawker. This biplane won nearly all the weekly Brooklands handicaps. Each time it won the gear ratio to the propellers was reduced, speeding up the engine and increasing the speed. I don't remember the exact figures, but it was probably worked up to 55 m.p.h.

The first Marconi wireless messages were transmitted and received by Mr. Bangay, on my monoplane. This was the first instance of receiving in the air in Europe, and the first of transmitting from an aeroplane in England (April and May).

The military trials were the great feature of the year. The weather was uniformly bad; it rained all day and every day, our tents leaked and blew down. No one was satisfied with either the trials or the result, yet I think the rules were fairly good, but they were too severe for an impoverished collection of experimenters who then represented British Aviation. It showed that aviation was not to be developed

by brains and hard work, the chief test being money. These trials mark the end of the early days of aviation; there were no more days of the old good-fellowship.

Aviation became a trade. Those who had worked for the love of the science, asking only the poorest food and lodging, were either dead or bankrupt, and so finished days which can never be repeated in the growth of a science. This example of a group of men sacrificing everything for the work has been seen in steam, electricity, motor-cars, etc., but never in quite the form shown in aviation, because the earlier engineering sciences did not necessitate living in communities, as did aviation. It is improbable that anything of the sort will arise again, because money has apparently become definitely the key to all progress. The next openings in science will probably be too elaborate for the needy worker. However, those few years in every country produced a similar condition, and it would be interesting to hear accounts from other aerodromes. Aviation in its present form has been built up by the failures and successes of those early pioneers.

THE CURTISS-REED METAL AIRSCREW

In most of the recent American air successes—the Schneider Cup, the Pulitzer Trophy, etc.—the winning, or record breaking, machines were equipped with the Curtiss-Reed metal airscrew. We give below a few notes, together with illustrations, of this successful component.

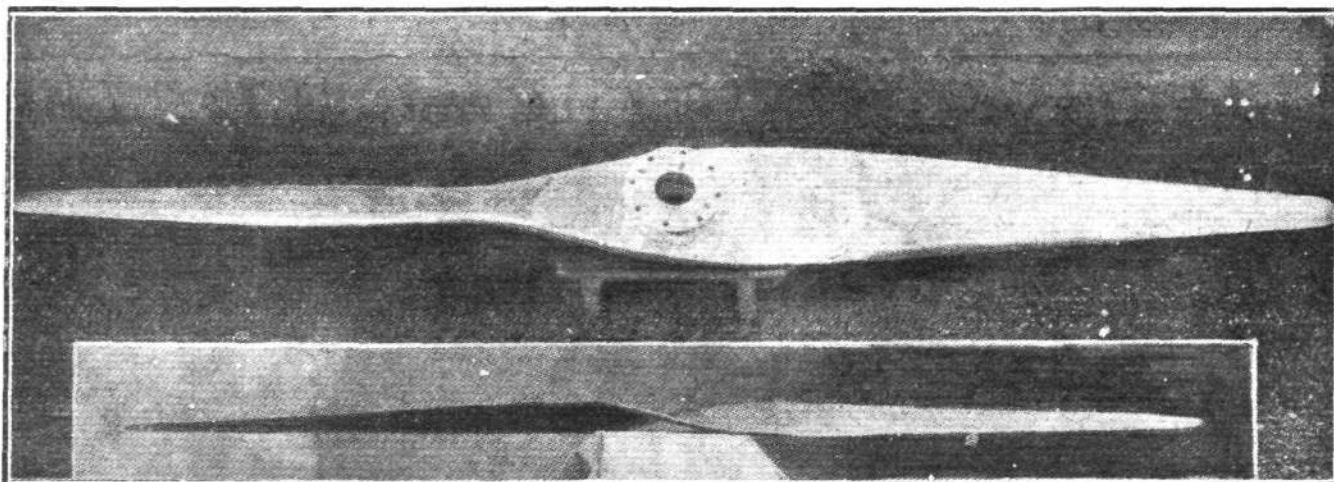
The Curtiss-Reed metal airscrew is quite novel both in design and construction. It is made from a single plate, about 1½ ins., of forged duralumin, tapering in thickness toward the tips, which is machined or otherwise formed to aerofoil sections, and then twisted to the correct pitch. It is then mounted with aluminium filler bosses fitting the central twisted surfaces on the same steel hub, which is used for wooden airscrews, thus being interchangeable with the latter.

The diameter of this airscrew comes out at about the same as that of a wooden one designed for the same service, and

successful results on its first trial (on August 30, 1921) when fitted to a Curtiss "Standard" machine with a 160 h.p. engine. A higher speed was obtained than with the wooden airscrew which it replaced. A few months after the same airscrew was tested successfully to 50 per cent. overload for 30 hours at McCook Field, and is, we believe, still in flying service.

Mr. Reed then proceeded to design and construct airscrews for trials on most of the typical aeroplanes of various powers, with a resulting improvement in speed in each case. The superior efficiency of this type of airscrew was further established by tests of a 3-ft. model by the N.A.C.A. at Stanford University by Dr. Durand, who reported the highest efficiency ever obtained for the same pitch ratio.

In the spring of last year the Curtiss aeroplane and Motor Co. entered into a contract to further develop and manu-



Two views of the Curtiss-Reed Metal Airscrew, which is made from a solid duralumin forging, machined to the correct aerofoil section and then bent to pitch.

the weight is also about the same—perhaps slightly greater. This airscrew is claimed to be semi-flexible, that is to say, it is rigid at the centre and resiliently flexible towards the tips, so that centrifugal force is mainly counteracting deflection.

The Curtiss-Reed airscrew is the result of several years of careful experiments with models by S. Albert Reed, an engineer who had specialised on research work in physical science, and who, after his retiring from active professional engineering resumed his researches in his private laboratory. His object was to design a propeller blade which could be moved through the air at very high speed, namely, above 900 ft. per second, with a minimum of wasteful resistance. After reaching over 1,500 ft. per second without any break in the continuity of the plotted curve of thrust and speed, Mr. Reed designed and constructed the first full-sized duralumin airscrew with knife-like blades. This airscrew gave

facture the Reed airscrew in the United States. The Curtiss Co. equipped all its 1923 special aeroplanes with this airscrew, viz.: the Navy-Curtiss seaplane racers for the Schneider Cup, Navy-Curtiss racers for the Pulitzer Trophy, Army-Curtiss Pursuit 'planes and the Curtiss Night Mail 'plane.

While Mr. Reed's object was the design of an airscrew of increased efficiency, and especially one which could be run at higher engine speeds without gearing, he appears incidentally to have obtained a successful solution of the metal airscrew problem as well. As this propeller is a single piece of metal without connections, welds, rivets or hollow spaces, it seems almost the last word in so far as simplicity is concerned.

Several Curtiss-Reed airscrews have already records of from 5,000 to 10,000 miles of flight without changing form, yet the pitch can be changed in the workshop in a couple of hours at least 20 per cent. higher or lower without detriment.

The Structure of Rigid Airships

WE would remind our readers that it is tomorrow, Friday, January 25, that Lieut.-Col. V. G. Richmond will read his paper on "Some Problems in Connection with the Structure

of Rigid Airships" before the Institution of Aeronautical Engineers. The meeting is to be held at the Engineers' Club, Coventry Street, and will commence at 6.30 p.m. Non-members of the Institution are invited.

THE ROYAL AIR FORCE

London Gazette, January 11, 1924

General Duties Branch

The following Pilot Officers on Probation are confirmed in rank:—I. B. Gray; Dec. 29, 1923. G. Coffin; Dec. 20, 1923.

Medical Branch

Flying Offr. F. K. Wilson ceases to be seconded to the Bristol Infirmary Jan. 2.

London Gazette, January 15, 1924

General Duties Branch

E. T. St. Maur Brett (Lt., Indian Army, retd.) is granted a short service comm. as Flying Officer, for seven years on active list, with effect from, and with seny. of, Jan. 9; Flying Officer G. Todd relinquishes his short service comm. on account of ill-health (Jan. 2); Flying Officer R. R. Soar, D.S.C., resigns his short service comm. (Jan. 16).

Medical Branch

E. G. Howell is granted short service comm. as Flight Lt., with effect

ROYAL AIR FORCE INTELLIGENCE

General Duties Branch

Air Commodore C. L. Lambe, C.B., C.M.G., D.S.O., to H.Q. Coastal Area, for special duty. 11.12.23.

Flight Lieutenants: H. H. James to R.A.F. Depot. 21.1.24. R. J. Read to No. 56 Sqdn., Biggin Hill. 28.1.24. A. R. Mackenzie to H.Q., Iraq. 5.12.23. V. R. Scriven, A.F.C., to No. 5 Armoured Car Coy., Iraq. 1.12.23. R. H. Hammer, M.C., to H.Q., Iraq, instead of to Basrah Group H.Q. as previously notified. 23.11.23. S. L. Quine, M.C., to Palestine Wing H.Q. 10.12.23.

Flying Officer G. M. Trundle to No. 4 Flying Training Sch., Egypt. 12.1.24. Flying Officers: N. C. Bretherton, F. W. Wiseman-Clarke, R. K. Emerson, H. W. A. Fox, R. W. M. Hall, J. V. Kelly, R. Legg, C. Lloyd, T. B. R. Meadmore; R. G. Peckover, R. W. Pilling, H. G. Radcliffe, E. H. D. Spence, L. P. Winters, J. Messer-Bennetts, E. T. St. M. Brett, all to No. 4 Flying Training Sch., Egypt, for course of instruction. 12.1.24. L. S. Hamilton and A. B. Smith, M.C., both to No. 2 Flying Training Sch., Duxford on appointment to Short Service Commns., for course of instruction. 14.1.24. C. H. Cahill to No. 1 Sqdn., Iraq. 5.12.23. L. T. Kerry to No. 6 Armoured Car Coy., Iraq. 5.12.23. H. W. Foote to H.Q., Iraq. 5.12.23. B. J. J. Nimmo to No. 6 Armoured Car Coy., Iraq, instead of to No. 3 Armoured Car Coy., as previously notified. 23.11.23. C. B. Bond to R.A.F. Base, Calshot. 21.1.24.

Pilot Officers: W. C. Adams, W. C. Barnsley, W. J. Brett, I. A. Bull, F. E. R. Dixon, M.C., J. J. Fitzgerald, S. E. Hall, B. F. H. Harding, R. W. Holden, R. O. Jones, H. T. Messenger, F. E. North, C. J. Pavia, J. E. Preston, H. W. Raeburn, M. Russell, G. A. Simons, H. G. Slater, F. T. Stacey, H.

from, and with seny. of, Dec. 31, 1923; Lt. G. A. Ballantyne, D.F.C., Dental Surgeon, General List, Army, is granted tempy. comm. as Flying Officer on attachment to R.A.F. (Jan. 1); he will continue to receive emoluments from Army funds.

Reserve of Air Force Officers

Flying Officer W. H. Howell relinquishes his comm. on account of ill-health, and is permitted to retain his rank (Jan. 16). The following officers are confirmed in rank with effect from dates indicated: Flying Officers A. G. Lamplugh (Dec. 21, 1923); E. A. Jones (Dec. 29, 1923); I. Welby, M.C., D.F.C. (Dec. 30, 1923); W. A. Campbell (Jan. 10). Pilot Officer W. F. Jaggs (Dec. 19, 1923).

Memoranda

The permission granted to Sec. Lt. A. H. Hill to retain his rank is withdrawn on his joining the Army; Sec. Lt. R. T. Carter is promoted to rank of Lt. (Oct. 15, 1918) (substituted for Gazette Feb. 10, 1920).

Erratum.—Gazette of Jan. 8 (FLIGHT, Jan. 17, p. 39) for T. B. R. Meadmore, read T. B. R. Meadmore.

Thomas, A. D. B. Trevor, G. M. Pitts-Tucker, W. Wynter-Morgan, M.C., all posted to No. 4 Flying Training Sch., Egypt, for course of instruction. 12.1.24. V. Harris to No. 2 Flying Training Sch., Duxford, on appointment to a Permanent Comm. for course of instruction. 14.1.24. L. W. C. Annable, E. C. Boucher, G. H. Jennings-Bramly, R. W. E. Bryant, S. E. Bullock, J. E. Clayton, R. K. Coupland, P. Cranswick, M.C., H. T. R. Cripps, L. R. Gladwin-Errington, E. H. Fielden, T. H. Finney, G. D. Green, P. P. Grey, G. S. Hall, A. F. Hutton, G. W. P. Irwin, A. J. McKellar, J. C. Marcy, D. J. Meager, F. W. Moxham, J. F. Nicholas, P. E. Nicholl, E. H. L. Pellew, D. Robinson, G. W. R. Russell, A. E. P. Smith, V. W. Soltan, C. F. Steventon, J. Summers, W. A. Tattersall, G. D. Venables, F. F. Wilkinson, J. F. Young, all posted to No. 2 Flying Training Sch., Duxford, on appointment to Short Service Commns. (on probation) for course of instruction. 14.1.24.

R.A.F. Staff College, Andover—Third Course

The following Officers have passed the qualifying examination for entrance to the R.A.F. Staff College, Andover, and are selected for the third course, commencing May 1, 1924:—

Wing Commander J. T. Babington, D.S.O.

Squadron Leaders: A. C. Maund, C.B.E., D.S.O., T. W. Mulcahy-Morgan, M.C., R. Collishaw, D.S.O., O.B.E., D.S.C., D.F.C., C. J. Mackay, M.C., D.F.C., N. H. Bottomley, A.F.C., and F. H. M. Maynard, A.F.C.

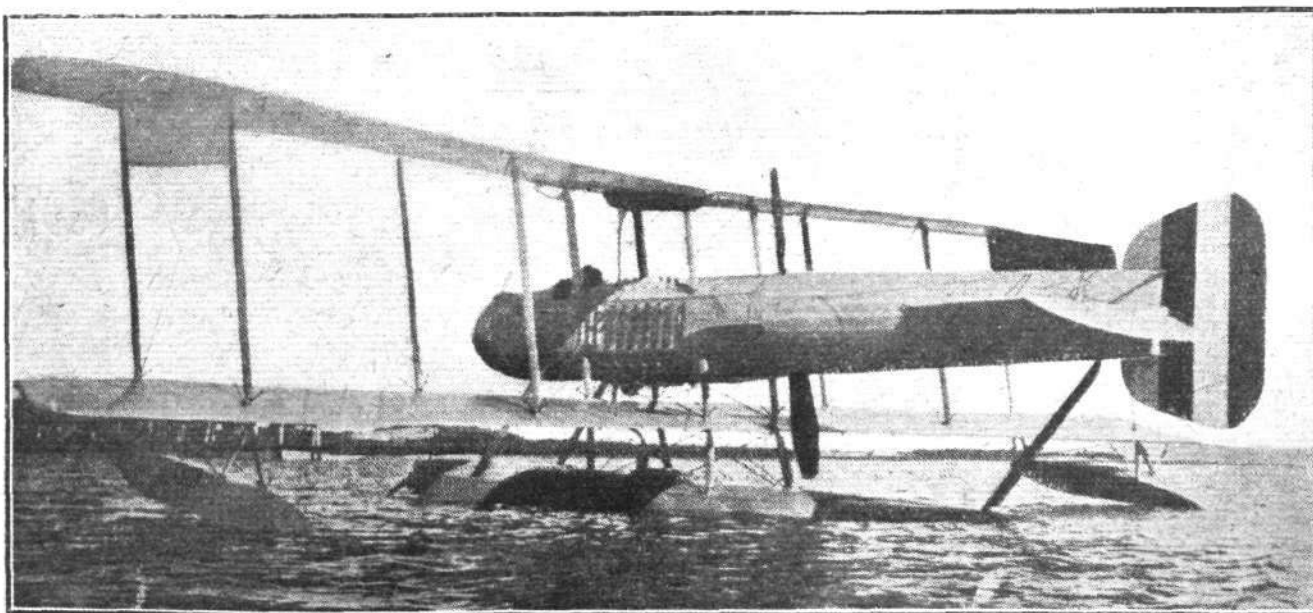
Flight Lieutenants: E. M. Pollard, G. C. Pirie, M.C., D.F.C., J. C. Slessor, M.C., L. G. S. Payne, M.C., A.F.C., J. P. Coleman, A.F.C., T. W. Elmhirst, A.F.C., T. E. B. Howe, A.F.C., C. H. Keith, J. W. B. Grigson, D.S.O., D.F.C., P. F. Fullard, D.S.O., M.C., A.F.C., J. H. Green, L. N. Hollinghurst, D.F.C., and C. J. S. Dearlove.

IN PARLIAMENT

R.A.F. Expansion

In the debate on the Address, Mr. Penny, on January 16, said there is one other matter, which is not allied to pensions so much, and that is in connection with the Air Force. In regard to the contemplated expansion of the Air Force, I wish to ask the Secretary of State for Air if he will give the fullest consideration to the claims of the senior ex-Service officers who at the present time are doing the bulk of the flying at the various stations, and who at present are excluded by the regulations from the advantage of permanent commissions and the pension relative thereto. There is considerable feeling in the Air Force on this matter at the present

time amongst the senior officers that they are placed in this position when new men are being engaged. I think, in view of their service, and of the rank to which they have risen, that the fullest consideration should be shown to them. It might be as well if the Secretary of State for Air—and it would entail no great difficulty—were to ascertain from the logs of the four main stations the percentage of the permanent commissioned officers who do the actual flying, and the hours they have flown during the past year. In the points I have raised my object has been to eliminate as far as possible dissatisfaction which can only react, if persisted in, to the detriment of this country.



AN UNORTHODOX SEAPLANE: The Gallaudet D.4, as used by the U.S. Naval Air Service. The outstanding feature of this machine is that the engine—a 400 h.p. Liberty—is located inside the fuselage (between the planes) and drives through an ingenious system of gearing a propeller mounted on, and “dividing,” the fuselage itself. This machine has a span of 46 ft. 4 ins. and an overall length of 33 ft. 5 ins., its speed being 126 m.p.h.

SOCIETY OF MODEL AERONAUTICAL ENGINEERS

THERE was a well-attended meeting at headquarters on January 24, when visitors were introduced to the Society. Discussion was opened on the models, exhibited at the Model Engineer Exhibition. Visitors complimented the Society on the excellent models shown, but some of the members seemed rather disappointed on account of the small number that were exhibited.

The Competition Secretary read a letter from Mr. Percival Marshall, who pointed out that in certain classes the rules had not been strictly adhered to, but to save any disappointment he requested that trials should be held at the earliest possible moment, when he would be pleased to make suitable awards.

It was decided there and then to hold flight trials for all Models and Gliders, with the exception of Compressed Air Models, at Sudbury, on Sunday, January 27, commencing at 10.30 a.m. prompt.

The Compressed Air Trials will be tried at Wimbledon on Saturday afternoon, January 26, at 3 p.m.

Members' attention is specially drawn to General Rule No. 3.

A. E. JONES, Hon. Sec.

MODEL ENGINEER EXHIBITION

Most of the models displayed at the Model Engineer Exhibition, just closed at the Royal Horticultural Hall, were of an exceptionally high standard. The model aeroplanes and aero engines, especially, showed a distinct improvement as compared with last year's exhibits. The Society of Model Aeronautical Engineers put up a very good display, and we were particularly impressed by the following models: P. Howe's enclosed tractor monoplane (very neat finish and an ingenious undercarriage); B. K. Johnson's enclosed fuselage tractor monoplane (25 seconds duration); C. A. Rippon's "Farman" monoplane; S. C. Hersom's hydro-tractor monoplane; and F. P. de Green's compressed air-driven tractor monoplane. G. Smith (an apprentice draughtsman at Sir W. G. Armstrong-Whitworth Aircraft, Ltd.) exhibited a 5-cylinder radial air-cooled aero engine of exceptional merit, both as regards design and finish. This engine has a bore and stroke of $1\frac{1}{2}$ in. and $1\frac{1}{2}$ in. respectively, and is fitted with a 2 ft. 10 in. diameter air screw. It has a maximum speed of 5,800 r.p.m., giving a maximum b.h.p. of 4.6. As its total weight is approximately $11\frac{1}{2}$ lbs., it weighs $2\frac{1}{2}$ lbs. per b.h.p., which is a remarkably low figure for a small engine of this type. The air screw gives a static thrust of 31 lbs. The whole engine was designed, patterns made, castings made and machined on a 4-in. Drummond treadle lathe, and the carburettor, sparking plugs and airscrew made entirely by Mr. Smith.

The "Shenandoah's" Great Adventure

On the evening of January 16 last the large American rigid Airship "Shenandoah," or "ZR.1," which for just on four days had been successfully moored at the steel mast at Lakehurst, N.J., was wrenched away from her anchorage by a violent gale, which had in the meanwhile arisen. It was 7 o'clock in the evening when the airship, with a crew of 21 officers and men on board, broke away and rapidly disappeared into the rainswept darkness. For an hour nothing was heard of the airship, as her wireless gear was temporarily out of action, and wireless messages were sent out to the various amateur radio stations asking them to help locate the airship. In this way several reports were received from various towns round about Newark stating that the "Shenandoah" had been seen drifting fairly low down. Then the airship succeeded in transmitting a wireless message, through a broadcasting station at Newark, to the effect that "everything was O.K." and that they were going to outride the storm. For hours the "Shenandoah" fought bravely against the gale until, about midnight, the force of the wind abating somewhat, she was able to make slowly, but surely, for home under her own power—having been carried some 60 miles inland away from her base.

Capt. Heinen, the German Zeppelin pilot who was in charge of the ship at the time, eventually obtained complete control, in spite of the fact that the bow of the ship was smashed in, and succeeded in bringing the "Shenandoah" safely back to Lakehurst in the early hours of the Thursday morning, January 17. The airship was greeted with enthusiastic cheers from the personnel at the Lakehurst station, and by 4.30 a.m. she was safely housed in the shed. A brief examination was immediately made, and it was stated that little serious damage had resulted, and that the proposed Polar flight, this summer, will not be abandoned on account of this adventure.

SIDE-WIND

ON January 15, at the Connaught Rooms, the twenty-first anniversary of the founding of the firm of H. M. Hobson, Ltd., Vauxhall Bridge Road, was celebrated by a dinner to the directors and various heads of departments, and a number of guests. It was certainly fitting that the "coming of age" of the firm should coincide with the occupying of the Presidential Chair of the S.M.M.T. by Mr. Hamilton Hobson during the twenty-first year of that Society. It is common knowledge to all, not only in the aeronautical world, but motor world alike, that Messrs. H. M. Hobson have made history, and secured a considerable number of world's records for the Claudel-Hobson carburettor. The fact that many distinguished guests were present at the above function must have afforded much satisfaction to the chairman and his co-directors—who, during the evening, were presented with handsome tokens of appreciation, in the shape of silver cigarette boxes, by the secretary and his colleagues, a delightfully worded speech accompanying the presentation.

Trade in Russia

WE have received the following information from Messrs. King's Patent Agency, Ltd., of 146A, Queen Victoria Street, E.C. 4. Legislation permitting the patenting of inventions in Russia under the new régime is now in a fair way to being consummated, and the Registration of Trade Marks may, it is hoped, after reciprocal treaties have been concluded, follow subsequently. British patentees and manufacturers are advised to be early in the field to secure priority, and thus protect their rights against infringement. The possessions of a patent or trade mark is not only a valuable asset to a business good will, but early protection is a necessary forerunner to the opening up of trade relations and the safeguarding of industrial rights therein. Messrs. King's Patent Agency will be pleased to furnish further particulars on application.

The Napier "Cub" Passes A.M. Tests

NOTIFICATION has just been received that the World's largest aero engine—the 1,000 h.p. Napier "Cub"—has been officially accepted by the British Air Ministry. The strenuous nature of the Air Ministry test is well known, including as it does five 10-hour runs at 90 per cent. full power. This is certainly a wonderful achievement on the part of the "Cub," and it speaks well for the excellence of Napier design and workmanship that Britain should hold such a wonderful lead in aero engine construction.

AERONAUTICAL PATENT SPECIFICATIONS

Abbreviations: cyl. = cylinder; I.C. = internal combustion; m. = motor. The numbers in brackets are those under which the Specifications will be printed and abridged, etc.

APPLIED FOR IN 1922

Published January 24, 1924

- 26,119. S. NONAKA. Aeroplanes. (208,792.)
27,548. J. R. SHELLEY. Aeroplane propellers. (208,836.)
28,133. C. DORNIER and DORNIER-METALLBAUTEN GES. Arrangement of parachutes in aircraft. (196,570.)
31,708. RAUL, MARQUIS OF PATERAS PESCARA. Four-stroke cycle I.C. engines. (189,151.)

APPLIED FOR IN 1923

Published January 24, 1924

277. SOC. DES MOTEURS SALMON (SYSTEME CANTON-UNNE). Means for securing thrust-bearings in position. (194,271.)

FLIGHT

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